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NOTICES OF INSECTS

THAT ARE KNOWN TO FORM THE BASES OF

FUNGOID PARASITES.

[*PRIVATELY PRINTED.*]

1858.

H. A. [illegible]

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NOTICES OF INSECTS

THAT ARE KNOWN TO FORM THE BASES OF

FUNGOID PARASITES.

VARIOUS writers since the commencement of the eighteenth century[1] have published from time to time on the existence of plants having attached to them insects in the form of roots, and much light has been thrown upon the subject by the discoveries that have taken place during the last few years. These, in most instances, have appeared in works, the authors of which have more especially described the plants, although occasionally the botanical descriptions are accompanied with short notices of the habits of the larvæ or caterpillars to which the plants are attached. It is intended in the present paper to refer more particularly to the insect-portion of the Entomophytes, with a view of throwing some light on the position they occupy in the System of Entomology, and, at the same time, to offer some observations, as far as our knowledge will permit, on their habits, and thus to endeavour to account for the mode in which insects become the bases of the singular parasitical plants or fungi by which they are infested.

An American author has justly observed, that it is the zoologist who "must decide upon the various kinds of animals that bear the vegetable forest or harvest," and it is his perfect coincidence in this remark which has induced the writer to compile the present confessedly imperfect account of the various species of insects which form the bases of the parasites, whether in the perfect or imago state, or in the pupa or larva stages of their existence. He trusts that it may be the means of drawing attention more particularly to the subject, and of thereby obtaining the cooperation of entomologists and others, who may have the opportunity of procuring information on this curious and interesting topic.

Five plates accompany this pamphlet, containing partly new figures, and partly copies from those given by other writers, which will be sufficient to convey a fair idea of the singular appearances presented by these compound animals and plants to those who may not possess any examples of them, and will offer the materials of comparison to those who are already partially acquainted with the subject.

Hampstead, 1858. G. R. Gray.

It is the intention of the writer to refer to these insects according to the position they occupy in the system; and this leads him in the first place to the Order COLEOPTERA, in which several species of *Carabidæ* have been recorded as attacked by fungoid parasites. The imago of *Carabus hortensis*, which Vahl[2] remarked was not only found dead, but in a state of decay. To the mouth, thorax, side of the sternum, at the joints of the legs, and at the joints of the abdomen, were attached a species of *Clavaria*, for which he proposed the specific name of *setiformis*[3]. Other species of this family have been found to be infested during the autumnal months with the *Isaria eleuteratorum*[4]; while a larva[5], probably of a species of *Carabus*, was discovered on the Pyrenees about 2400 feet above the sea, having growing on it the *Sphæria entomorhiza*.

The larvæ and perfect insects of this family reside beneath stones, under the bark of trees, between clods of earth, in decaying vegetables, and in moss growing at the base of trees. They undergo their final metamorphoses in the autumn; on the approach of winter they hybernate in moss, &c., until the return of spring, when they may be seen wandering about paths, &c., in search of their prey, which consists of herbivorous larvæ and beetles.

Three species of the genus *Brachinus*, viz. *B. crepitans*, *B. sclopeta*, and *B. explodens*, have been found by M. Rouget[6], during spring and autumn, to be infected, while living, on the *surface* of their antennæ (Pl. I. f. 16), thorax, elytra, and legs, with a very curious minute yellow-coloured fungus, which has been named *Laboulbenia Rougeti*[7]. M. Rouget says they are obtained on the mountains in the environs of Dijon, in dry as well as in low and moist places.

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[1] The earliest account of an Entomophyte has been referred to by Mr. H. Hull in the *Proceedings of the Royal Society of Van Diemen's Land for* 1853, p. 183, who tells us that in the writings of Christian Franc. Paulinus, in the ninth century [this writer lived in the end of the seventeenth and the beginning of the eighteenth centuries], will be found the statement "that certain trees in the island Sombrero in the East Indies have large worms attached to them under ground, in the place of roots," &c.

[2] *Naturhist. Selsk. Skrivt*, 1792, 2 band, 2 heft, p. 50.

[3] Probably the same as Isaria eleuteratorum?

[4] Nees von Esenb. *Syst.* 86. t. vii. f. 84; Ch. Rob. *Végét. Paras.* p. 607.

[5] Lucas, *Ann. Soc. Ent. de France*, 1849, vii. p. xl.; Ch. Rob. *Végét. Paras.* p. 661.

[6] *Ann. Soc. Ent. de France*, 1847, p. xxxiv.; 1850, p. 21. t. 3. f. 1.

[7] Mont. & Ch. Rob. *Ann. Sci. Nat.* 1849, p. 233; Ch. Rob. *Végét. Paras.* p. 622. t. viii. f. 1, 2, et p. 639. t. x. f. 2.

The habits of these insects are similar to the last; but they usually frequent damp places on the margins of great rivers and estuaries.

M. Rouget has also recorded three species of *Staphylinidæ*, viz. *Goerius olens*, *Pæderus riparius*, and *Ophonus brevicollis*, as affected by the minute parasite, *Laboulbenia Rougeti*[1]; while M. Lebert states that the *Goerius olens* is also subject to a new disease, that shows itself in spots, in each of which fungi[2] are to be found, occupying the outer ring or its interior.

These insects reside in damp places on the margins of rivers, beneath dead leaves, and under the bark of decaying trees. Their food consists of decaying animal and vegetable matter, especially fungi, in which some of the species chiefly pass their existence.

A new species of *Gyrinidæ* from the Cascades of Caraccas, which has been named *Gyrites sericeus* (Pl. I. f. 17) by Ch. Robin and Laboulbène[3], has a very minute parasite, the *Laboulbenia Guerini*[4], attached to the *surface* of the thorax, between the thorax and abdomen and the margins of the elytra.

This is the only true aquatic insect which has hitherto been recorded as having a parasitic fungus attached to it. The insects of this family pass their larva and perfect states in the water; but when the larva is about to assume the pupa state, it creeps out of the water up the stems of some plant that grows on the margin, and then envelopes itself in an oval cocoon, which is pointed at each end.

The larva represented by Dickson may probably belong to the *Silphidæ*?; it is that on which grows the typical example of the *Sphæria entomorhiza*[5], springing from the pectoral portion of the thoracic segments.

Many of these insects frequent decomposed animal and vegetable substances, both in their larva and perfect states. Others reside under the bark of trees and in fungi.

Several large lamellicorn larvæ have been recorded by various writers[6] as thus infested, which, from the formation of their antennæ, are here placed provisionally in the family *Dynastidæ*; although, from our imperfect knowledge of the peculiar characters of the various larvæ, it is impossible to affix any generic or specific names to them for the present.

These larvæ (Pl. I. f. 5, 6, 9, 10) are usually found in tropical countries, buried a few inches beneath the surface of the soil, which generally consists of leaves, fibres, and roots of plants in a state of decomposition, and are especially fond of places that are used as potato patches by the inhabitants, even on the elevated plateau of the Andes to the height of 2400 feet above the sea. They form themselves chambers in which they reside, by feeding on the decayed vegetable matter that surrounds them. They remain for four or five years in their larva state before they undergo their change into the pupa, previous to their final metamorphosis into the perfect insect; so that it may be easily supposed that the larvæ have ample time to get affected with the germ of the fungoid parasite, especially during rainy seasons. There can be no doubt that it commences its growth internally, as specimens have been met with having the fungus just bursting forth from the mouth and other parts of the body, "resembling a green pea;" but the most usual place is from the pectoral surface of the thoracic segments, and from between the segments and from the spiracles of the abdomen, the specimens varying, however, much in position, number, and mode of growth. These larvæ, from their unwieldy proportions, lie on their side within the chamber amidst the decaying vegetable detritus, and thus cause the fungus to partake of various contortions (Pl. I. f. 5), arising from the limited space in which it is confined, from its incapability to make its way through the vegetable detritus, or from the depth it might be when growing. It invariably projects upwards towards the surface of the earth, even should it commence its growth from the side of the jaw, or of the abdomen, on which the larva lies. The larvæ are usually found dead, and sometimes partly decayed; but this latter circumstance may greatly depend on the length of time during which they have lain in the damp soil after death, their death having been occasioned in the first instance by the growth of the parasite. On the other hand, it has been recorded by Mr. Mackay[7], that the larva obtained at Maracaibo[8] "was *alive* when first found;" and it is added, that "this is by no means a solitary instance in which these vegetable productions have made their appearance on living insects."

Though the larvæ of these insects are numerous and easily found in some localities, yet it may be remarked that periods of several years often elapse before specimens with fungi are again discovered, which seems to depend entirely on the return of a wet season at certain portions of the year, producing a certain condition of the insect which appears to be essential to the development of the fungoid parasites.

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[1] Ch. Rob. *Végét. Paras.* p. 636.

[2] Panhistophyton ovatum, *Lebert*, Berl. Entom. Zeit. 1858, p. 170; Nosema bombycis, *Nägeli*.

[3] *Ann. Soc. Ent. de France*, 3 sér. i. p. 48. t. 11. f. 1.

[4] Ch. Rob. *Végét. Paras.* p. 624. t. ix. f. 1–3, et p. 637.

[5] Dickson, *Plant. Cryptog. Brit.* p. 22. t. 3. f. 3 (1785); Kirby and Spence, *Introd. to Ent.* iv. p. 208.
Xylaria entomorhiza, *Gray*, Nat. Arrang. of Brit. Plants, i. p. 511.
Sphæria (Cordyceps) entomorhiza, *Berkel.*

[6] Kirby and Spence, *Introd. to Ent.* iv. p. 208; Westw. *Journ. Proc. Ent. Soc.* iii. p. v. pl. iv. f. 6; Ch. Rob. *Végét. Paras.* p. 664; Waterhouse, *Journ. Proc. Ent. Soc.* iii. p. xxxvi.; Ch. Rob. *Végét. Paras.* p. 665; Stevens, *Journ. Proc. Ent. Soc.* 1853, p. 109; Waterhouse, *Proc. Zool. Soc.* 1839, p. 146; Leidy, *Proc. Acad. Nat. Sci. Philad.* 1851, p. 235?

[7] *Proc. Zool. Soc.* 1839, p. 146.

[8] Where it is known to the natives by the name 'Projojoy.' See under this word in *Maunder's Scient. Treas.* 1843.

Pl. I. f. 9 represents what is probably the young of the same kind of larva, but which does not exhibit the appearance of having the body so entirely filled with the thallus internally; yet from the dorsal portion of the thoracic segments, where the thallus is spread over the surface, grows a long thick fungus of the length of two inches and a quarter, having a somewhat lengthened clavate head[1]. Another example (Pl. I. f. 10) consists only of the head and thorax of the same kind of larva, but which is not in any way infested with thallus; though from the pectoral portion springs a lengthened stem of a fungus, which is curiously divided, as if cut into two slender branches for about half its length, each of the branches being much curved, and furnished with an oblong head at the apex. Both these fungoid parasites have evidently grown for some part of their length above the soil, and they exhibit an entirely different habit from any previously described. They were brought by Mr. Velez from New Grenada, and are now deposited by him in the British Museum.

Mr. Jervis has also kindly mentioned that he is acquainted with a *Scarabæus* (*Dynastes?*), apparently in the perfect state, which had been found in the hotter parts of New Grenada, having a fungoid excrescence[2] attached to it.

It may be here noticed that "a large kind of brown beetle" is recorded by the Rev. Mr. Taylor[3], under the New Zealand name of 'Mumutana,' as abundant "amongst the sand-hills in the vicinity of the sea." This insect, he states, is sometimes found "completely filled with the nut-like substance, but in no instance has he noticed any plant shooting from it."

Among *Melolonthidæ* must be noticed the *Melolontha vulgaris*, which has been recorded as in a broken and decayed state, having the sides of the body and legs infested with small round spots of a fungus called *Lycogale fragilis* by Holm[4].

As the four following larvæ also form part of the same family, their habits may thus be given together under one head. Like those of the last-mentioned family, they pass the chief portion of their existence in the earth, *i. e.* from the egg-state until they are on the point of undergoing the metamorphosis into the perfect state. Their larva state being much prolonged, they are very destructive to grass and other plants that clothe the surface of the soil, by feeding on their roots, while traversing the burrows which they make in search of such food.

Fougeroux de Bondaroy[5] has described a larva which most probably belongs to *Rhysotrogus* or *Ancylonycha*. The parasite on this larva is represented by the author as growing from a broad base of thallus, which is deposited *externally* on the upper side of the larva, in which respect it differs from most others that have been recorded. In proof of his opinion, he states, that in some specimens which had been preserved in spirit of wine, the plant had separated from the body of the larva, and exhibited the under surface of the basal part of the stem or thallus of the parasite fluted (Pl. I. f. 3), as if occasioned by only lying close to the outer surface of the abdominal segments of the insect. This mode of separation, however, may have been entirely caused by the action of the spirit upon the Entomophyte; but as the larva retains in some measure its perfect form, it may be inferred that its interior was previously filled with the thallus; and that, as in other recorded Entomophytes, it was not until after this had taken place that the fungus showed itself externally, as is evidently exhibited in Pl. I. f. 1, where it is represented bursting forth between two of the dorsal segments of the thorax. This manner of growth of the parasite may probably be caused by the position of the insect at the time it was exhausted by the progress of the thallus internally, the point of external growth being the nearest portion to the surface of the earth. The latter remark is also applicable to the other figures (f. 2, 3, 4), which at the same time afford evidence that the plant had grown above the surface of the soil. It is usual to find only one parasite on each larva (Pl. I. f. 4), although in some two, and in others even three (Pl. I. f. 2) have been noticed, varying much in length and form. It is remarked by the Rev. Mr. Berkeley, that the greater part of the fungi represented on pl. 5 of Fougeroux's Memoir belong probably to *Sphæria entomorhiza*[6].

Some larvæ described by Mr. Cist in 1824[7], as found in North America, were considered by the late Count Dejean to be those of *Ancylonycha puncticollis*[8]. "It is not unusual," says Mr. Cist, "to find a number of the larvæ which have attached to them vegetable sprouts, in some instances 3 inches long." These excrescences generally proceed from the space "between the head and under part of the thorax, and in a few instances from the mouth." He further remarks, that in every case where he observed the vegetation, "the grub was not only dead, but in a state of decay." The sprout arising above the surface of the ground is the indication where the animal lies.

This may be the same larva that is referred to by Mr. Mitchell[9] as "found in wood-yards, around the stumps of dead trees, and often in sward-ground; in the latter it does extensive damage by devouring the roots of grass and of plants that fall in its way." The fungus at times appears in many places, rising to the height of several inches above the surface of the earth.

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[1] It bears a great similarity to the Cordyceps Ravenelii, *Berkel.*

[2] The natives gravely assured Mr. Jervis that this excrescence would be transformed into, or become, a large tree, called 'Diomato,' a name which is applied to a species of Diospyros remarkable for its hard and beautifully-veined wood.

[3] Taylor, *New Zealand*, p. 423.

[4] *Acta Hafn.* 1781, i. p. . t. . f.

[5] *Mém. de l'Acad. Roy. des Sci.* 1769, p. 467. t. 5. f. 1–9.

[6] *Lond. Journ. of Bot.* ii. p. 207.

[7] *Sillim. Amer. Journ.* viii. p. 270. pl. iv.

[8] Dej. *Cat. des Coléop.* p. 177.

[9] *Sillim. Amer. Journ.* xii. p. 26.

Similar kinds of larvæ are also found in South Carolina during the spring and summer months. But their parasites[1] differ entirely from those usually found on this kind of insect, both in their manner of growth and general appearance. They are composed of a long and somewhat thick stem with a lengthened and subclavate head, and plainly evidence that part of the fungus had been exposed above the surface of the vegetable detritus.

Some larvæ were discovered near Sta Fé de Bogota by the late Mr. Stevens, which may possibly belong to the genus *Ancylonycha*, but certainly to a smaller species than those just noticed. These larvæ bear a great similarity to those mentioned by Mr. Cist, and, like them, the parasite invariably arises from beneath the head and the prothorax; in one specimen it has just made its appearance (Pl. I. f. 7), in another it is about 2 inches long, while in a third it reaches to about 6 inches in length (Pl. I. f. 8), of nearly equal thickness throughout, and having the tip somewhat acute and of a light colour. These examples were no doubt discovered, like those observed by Mr. Cist, by the principal portion of the fungus appearing above the surface of the vegetable soil.

In the family *Cetoniidæ* two instances have been recorded by M. Riche[2], one of which occurs in a species of *Cetonia* from Madagascar, having a fungus proceeding from its head; while the other is in a species of *Gymnetis*, having a similar production on the thorax. As he neither gives further description nor figures of these two Entomophytes, they must remain thus briefly noticed.

In South Carolina there have also been observed during the autumnal months several larvæ, which showed that they were but slightly buried in rotten logs, as they had roots springing from around the base only of the stem. These insects, judging from the figures, may possibly belong to the family *Elateridæ*. The parasite[3] differs in form from any of those hitherto known, being long, slender, and with the middle of each stem swollen by the mass of sporules; but the stem is sometimes found perfectly simple.

Various species of *Curculionidæ* appear very liable to become the bases of fungoid parasites, viz.,

Heilipus celsus[4], Schœnh., of Cayenne, Pl. I. f. 15.
—— *brachypterus*[5], of Brazil, Pl. V. f. 4.
—— *hylobioides*, of Brazil, Pl. I. f. 11.
——, n. sp. ?, of Ega.
Chalcoderma —— ?, of Para, Pl. I. f. 14.

These insects have the thallus protruding from the proboscis, the joints of the body, and along the suture of the elytra; while from between the thorax and elytra spring one (Pl. I. f. 11, 14) or two, and even three long slender excrescences; and others sometimes proceed from different parts of the body (Pl. I. f. 15). The apical portion of these fungi is usually tapering and light-coloured.

In some other species, as

Heilipus, n. sp., of Lima[6],
Dionychus —— ?, of Brazil[7],
Auchonus —— ?, of St. Vincent, Pl. I. f. 13.

The lengthened fungi noticed on these insects also proceed from between the thorax and elytra; but they have at the apex of each projection a clavate head of a pale colour. In some examples the stem has been observed to bebranched.

Other species of this family are subject to become the bases of a very different kind of fungoid parasite, viz.,

Hypsonotus clavulus, Germ., of Brazil[8].
Pycnopus bufo[9], Say, of Brazil[10], Pl. I. f. 12.
Rhyssomatus —— ?, of the Amazon.

These insects have the thallus surrounding the abdomen, and sometimes extending between the thorax and elytra, from which spring numerous short excrescences having tuberculated heads of a yellow colour. This kind of parasite has been named *Stilbum Buquetii*[11].

A specimen of *Calandra* is referred to by Messrs. Kirby and Spence[12] as having a fungus projecting from its rostrum.

The insects of this family, which are very numerous in tropical climates, live entirely on vegetable substances, and many of them are apterous; they are not unfrequently seen on the leaves, or in cracks and cavities in the bark of trees, and in the interior of stems of plants, &c. Some species are, however, found by turning over the partly decomposed leaves which lie on the ground, and the rotten trunks of fallen trees: such localities probably facilitate these insects becoming, during rainy seasons, the bases of the different kinds of fungoid parasites.

The only coleopterous insect that now remains to be noticed belongs to the family *Erotylidæ*, and is the *Erotylus tæniatus*[13] of Columbia. It is remarkable for producing occasionally from the head, from between the head and thorax, and from the sides of the body, a number of very "slender vegetable appendages[14]" (Pl. I. f. 18), the apex of each ending in a small tuberculated head of a yellowish colour.

The species of this genus are seen flying about during the day in the dense forests of the tropical regions of the New World; when in repose, they seek the leaves of plants; while in the larva state, however, they live under the bark of trees or in fungi; but they chiefly feed upon decayed vegetable matter.

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[1] Cordyceps Ravenelii, *Berkel. & Curt.* Journ. of Proc. Linn. Soc. 1857, p. 159. pl. . f. .

[2] *Bull. Soc. Ent. de France*, 1849, p. lvi.

[3] Cordyceps stylophora, *Berkel. & Broome*, Journ. of Proc. Linn. Soc. 1857, p. 158. pl. 1. f.

[4] Ch. Rob. *Végét. Paras.* p. 650. t. viii. f. 6, Sphæria entomorhiza.

[5] Newm. *Zoologist*, 1858, p. 5927.

[6] Ch. Rob. *Végét. Paras.* p. 650. t. viii. f. 5, et t. xii. f. 2, t. x. f. 8, Sphæria entomorhiza.

[7] Hope, *Journ. Proc. Ent. Soc.* ii. p. iv. pl. 8. f. 8.

[8] Ch. Rob. *Végét. Paras.* p. 640. t. ix. f. 4, 5.

[9] Prionopus lignarius, *Dej.*, P. griseus, *Perty*.

[10] Ch. Rob. *l. c.* p. 640. t. viii. f. 3, 4.

[11] Mont. & Ch. Rob. *Végét. Paras.* p. 640. t. xi. f. 1, 2, 3.

[12] *Introd. to Entom.* 1826, iv. p. 208.

[13] Latr., *Dejean, Cat. des Coléop.* p. 449.

[14] Parry, *Journ. Proc. Ent. Soc.* 1847, p. iv.

The LEPIDOPTERA are divided into two sections; the first of which embraces the *Lepidoptera Rhopalocera*, or Diurnal Lepidopterous Insects. These, however, require but a brief notice, as they have hitherto remained unrecorded as being the bases of parasitical fungi, or even of filamentous species or moulds,—and this notwithstanding the fact that most of these insects pass their existence and undergo their metamorphoses, as it may be said, in the air, where the seeds of these singular plants are stated to float, and thereby, in the opinion of some writers, get affixed to insects in their different stages of life; notwithstanding also that their food entirely consists of vegetable matter, which is supposed to be one of the chief channels by which the spores or seeds are conveyed into the interior of insects, where they are thought to lie dormant until some extraordinary coincidence awakes them into active life. Yet this section of Lepidopterous insects has, so far as is known, escaped from becoming the bases of these fungoid parasites.

It is different, however, with the next section, which consists of *Lepidoptera Heterocera*, or Nocturnal Lepidopterous Insects. It embraces various families.

The first family is composed of *Sphingidæ*: various species belonging to several genera have to be noticed, as attacked by fungoid parasites or moulds, viz.,

Pachylia achemenides[1], of Surinam.
Macrosila collaris[2], of St. Domingo, Pl. III. f. 12.
Sphinx carolina[3], of North America.
Anceryx Ello[4], of Para.
Anceryx pinastri[5], of Europe.
Smerinthus populi[6], of Europe.
Sphinx ? —— ?[7], of Jamaica.
Sphinx ? —— ?[7], of Guadaloupe.

All these insects are infested in their imago or perfect state, and are usually found, principally during or after the rainy season, attached to a leaf or trunk of a tree, sitting with their wings at rest, as if they had been suddenly exhausted by some peculiar action that progressed internally. This eventually shows itself in the form of a fungoid matter or mould[8] entirely covering the external surface of the body and the principal nervures of the wings; at the same time, the margins of the latter and the basal joints of the legs become firmly attached to the leaves or trunks of trees; the fungus then grows rapidly on the head and thorax, and especially from the joints of the abdomen, in the form of slender filaments of various length and thickness. The parasite varies in different specimens: in some the filaments are rather thick, and sometimes flattened, especially at their base, reaching in the longest example to the length of about nine lines; while in others, they are slender and minutely branched on the sides, attaining the length of an inch and a half to two inches. There seems no doubt, from the position in which these are discovered, that the parasite was, as observed by Dr. Halsey[9], "evolved while the *Sphinx* was yet in a state of existence:" but the fungus does not become fully developed externally until after the death of the insect; and it is usually more or less in a state of decay, dependent upon the length of time it has remained on the leaf or trunk after the development of the parasitical mould before it is discovered. The caterpillars of this family pass their life exposed to the atmosphere, in the same manner as those of Diurnal Lepidoptera, which appears equally to protect them from the attacks of the parasites. The chrysalides, on the contrary, bury themselves in the earth, to await their final metamorphoses; yet they also have not been found affected with fungoid parasites.

The next group, which produces several fungoid caterpillars, possesses the singular character of having its caterpillars covered on the segments of the thorax by horny shields, varying in form and strength, which protect that part of the insect while burrowing and forming chambers, either in the earth or timber, in which they reside. These characters not only differ in the genera, but also assume slight variations in the species of the same genus, giving rise to modifications in the form of the shields.

It embraces several families: the species about to be referred to belong to the *Hepialidæ*. In this family, the horny shields partake more or less of the character of the trans-

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[1] Sphinx achemenides, *Cram.* Pap. Exot. t. 267. f. A, B; *Griff.* Anim. Kingd. Ins. ii. pl. 137. f. 1.
Pachylia achemenides, *Walk.* List. Lep. Heter. B. M. viii. p. 191.

[2] Macrosila collaris, *Walk. l. c.* p. 201.

[3] Sphinx carolina, *L.*
Phlegethontius carolina, *Hübn.*, *Walk. l. c.* p. 216.

[4] Sphinx Ello, *L.*
Anceryx Ello, *Walk. l. c.* p. 224.

[5] Sphinx pinastri, *L.*, *Lebert*, Berl. Ent. Zeit. 1858, p. 179.
Anceryx pinastri, *Walk. l. c.* p. 223.

[6] Phalène radicante de R. P. Engramelle, *Richard*, Journ. de Phys. xv. p. 402 (1780).
Sphinx populi, *L.*, *Ernst*, Pap. Eur. iii. t. 115. f. 162. m. (1782).
Smerinthus populi, *Godart.*, *Walk. l. c.* p. 243.

[7] Mitchell, *Sillim. Amer. Journ.* xii. p. 22.

[8] Byssus ——, *Richard*, Journ. de Phys. 1780, xv. p. 402.
Isaria sphingum, *Halsey*, Ann. Lyc. of N. Y. 1823, p. 125.
Isaria sphingium, *Schwein*, Carol. n. 1298; Ch. Rob. *Végét. Paras.* p. 610.
Isaria sphingophila, *Link*, Spec. ii. 114.
Mr. Mitchell thinks "that the seeds were scattered on the back and sides of the" caterpillar, "which was exposed everywhere to their influence, ... whereupon it might be inferred they would germinate and enlarge until after the beginning of the fourth metamorphosis, when they would probably overcome their supporter."—*Sillim. Amer. Journ.* xii. p. 24.

[9] *Ann. Lyc. of New York*, 1823, p. 125.

verse scales on the separate segments of the thorax, as is exemplified in the caterpillars of the European species of *Hepialus*. It may be remarked, that more than one-third of the described species of this family are found in what are designated the Australian regions: viz. New Zealand, 6; Australia, 9; and Tasmania, 10—making in all 25 species. As their metamorphoses are at present unknown, it is impossible to appropriate with certainty the generic and specific names to all the caterpillars on which the parasites are found.

The caterpillar[1] of the New Zealand Entomophytes has the prothorax entirely covered; the mesothorax has an anterior and a posterior transverse shield, with a somewhat quadrate spot of the same horny substance on the lower part of the side; while the metathorax is furnished with a narrow anterior transverse shield, with a subtriangular and a subquadrate small shield on each side beneath it. The anal segment of the body is also apparently protected by a horny covering.

These caterpillars are usually found in certain districts during spring beneath the 'Rata'[2] and the tree-ferns[3] that grow in a light, porous, and peaty soil, under which the caterpillar burrows perpendicularly in search of its food, consisting of the young and fibrous roots of those trees, and afterwards forms horizontal chambers in passing from one root to another. These roots generally extend to a distance from, and form a circle round, the trunk; the moisture that drops off the leaves keeps the soil in a certain degree of softness, which is beneficial in several ways to the insects. These reside entirely in the earth during the first two states of their existence, as caterpillar and as pupa; and it is not until the third or perfect state that they are seen flying about, or settling on the plants in the neighbourhood of their late abode. The perfect state (Pl. II. f. 5[4]) is known to entomologists under the name of *Charagria virescens*[5]; it is of a buffy-white satiny colour, with green irregular lines distributed over the surface of the upper wings, while the under wings are of a greenish white. There is also a second species, named *C. rubroviridans*[6], which is of a larger size, and has the under wings of a pale rusty colour. The caterpillars of both these species may readily become the bases of this fungoid parasite, as their habits are altogether similar.

The female deposits her eggs in the crevices of the bark of trees and between the fronds of the tree-ferns near the surface of the earth, which the insects of this family are enabled to do by the attenuation of their abdomen and its great capability of extension, which allows it to become an ovipositor of considerable length. As soon as the young comes into existence, it burrows into the earth in search of its food; and it is certain that the caterpillar does not pass any portion of its life on trees, as is supposed by some writers; but the insect remains in the earth during the first two stages of its existence. It is probable, therefore, that the parasite becomes connected with the caterpillar by means of the seed being taken with the food, and thus passing into the interior of the insect, which had previously become sickly and weakened by the rains, which fall at times in great quantities, saturating the earth around it. It is certainly only after such atmospheric influences that the germination of the plant predominates over the growth of the insect[7], which is found of various ages with the fungus in different stages of growth. The interior of the insect becomes completely filled by the inner plant or thallus; after which, the growing head of the outer plant or fungus, passing to a state of maturity, usually forces its way out through the tissue of the joint between the head and first segment of the thorax. The fungus[8] grows to various lengths, reaching in some examples to the length of ten or more inches: of course this depends in a great measure on the depth to which the caterpillar may be buried at the commencement of the outward growth of the fungus. It is stated that this caterpillar "settles head upwards to undergo its change when the vegetable developes itself[9]." But it is evident that the caterpillars are subject to the full development of the parasite at various periods of their growth; certainly some of them, from their size, are attacked long before they are sufficiently matured to place themselves in that position which it is necessary for them to assume

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[1] Caterpillar from New Zealand, *Childr*. Journ. of Proc. Ent. Soc. 1836, p. vi.; *Evans*, *l. c.* 1838, iii. p. iv. pl. vi. f. 4; Ch. Rob. *Végét. Paras*. p. 644; Taylor, *New Zealand*, p. 423. fig. , p. 424 et 425.

Bullrush caterpillar, *Tayl.* Tasm. Journ. ii. p. 307.

Vegetable or Bullrush caterpillar, *Thompson*, Medical Times, 1843, p. 65, et 1844, p. 200; Thomps. *Calc. Journ. of Nat. Hist.* 1845, p. 71.

Parasitic Fungus from New Zealand, *Pereira*, Pharm. Journ. ii. p. 593.

[2] Colenso, *Lond. Journ. of Bot.* i. p. 304. It is a species of Myrtle, Metrosideros robusta. See also *Proc. Roy. Soc. V. D. L.* 1850, p. 289.

[3] Berkel. *Lond. Journ. of Bot.* ii. p. 209; Hook. *Flora New Zeal.* p. 202.

[4] *Pharm. Journ.* iv. fig. p. 206.

[5] Walk. *List of Lepid. Heter. B. M.* vii. p. 1569.

Hepialus virescens, *Doubl.*, Dieffenb. Trav. in New Zealand, App. ii. p. 284; *Pharm. Journ.* ii. p. 594, iv. p. 205.

[6] Walk. *List of Lepid. Heter. B. M.* vii. p. 1570; Tayl. *New Zeal.* pl. 1. f. 1.

[7] "The parasite is never known to germinate except in connexion with the body of one of these caterpillars."—*Med. Times*, 1843, p. 65. The New Zealander's name for this plant-caterpillar is 'Hotete,' 'Aweto,' 'Weri,' and 'Anuhe.' The natives eat the plants, which when fresh have the "flavour of a nut*;" "and also use them, when burnt, as colouring matter for their tattooing, rubbing the powder into the wounds, in which state it has a strong animal smell †."

[8] Sphæria larvarum, *Hook.*, Westw. Journ. of Proc. Ent. Soc. 1836, p. vi.

Sphæria Robertsii, *Hook.* Icones Plant. i. pl. xi.; *id.* Journ. of Bot. 1841, iii. pl. 1. A; Colenso, *Lond. Journ. of Bot.* 1842, n. s. i. p. 304; Hook. *l. c.* ii. p. 209; Pereira, *Pharm. Journ.* ii. p. 593. fig.

Sphæria Robertsia, *Tayl.* Tasm. Journ. 1842, p. 307; Thomps. *Med. Times*, 1843, p. 65, et *l. c.* 1844, p. 200. fig.

Sphæria Forbesii, *Lond. Journ. of Bot.* 1848, vii. p. 578.

Sphæria (Cordyceps) Robertsii, *Ch. Rob.* Végét. Paras. pp. 648, 655. t. xiii. f. 4–9.

[9] *Lond. Journ. of Bot.* 1843, ii. p. 209.

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* Taylor, *New Zealand*, p. 425. † Taylor, *Tasm. Journ.* 1842, p. 307.

before they undergo their final metamorphosis. This idea may have originated from the specimens having the parasite usually projecting forward; but it may readily be observed, on examining them, that the base of the plant invariably rises perpendicularly[1] (Pl. II. f. 3) from its origin before it is bent, as if the caterpillar had become stationary in a horizontal or nearly horizontal position in consequence of its being affected by the internal thallus, and the plant had then naturally made its way directly upwards through the peaty soil to the surface, which it would eventually appear to surmount by two or three inches, which portion becomes granulated when matured. It may be added, from information conveyed to the writer, that the fungus, after appearing above the earth, has been gradually withdrawn through the loose soil with the caterpillar attached, when the latter has been found in a living state: of course in such a case the caterpillar was not buried far in the soil, and therefore the fungus was short and easily removed[2].

The stem of this parasite, it may be remarked, is sometimes slightly coated on the part which is near the surface of the earth with a white woolly matter; the stem is also slender and somewhat weak in proportion to some others, and it appears to be often broken, when a new stem arises from or near the same place,—which, it is said, is "not known to occur in any other plant with which we are as yet acquainted in the vegetable kingdom[3]."

A copy of the figure of Corda[4] is given in Pl. II. f. 4, as it represents the plant proceeding in a perpendicular manner from the "tail[5]" or anal portion of the caterpillar. Such examples must be rare; for though a great many specimens of this Entomophyte have been examined by the writer, yet he has never met with it in a single instance. A specimen has also been recorded "with an undeveloped stipes growing out of the tail of the caterpillar, as well as one from the back of the head[6]."

This caterpillar differs from all the others by having its surface coated with earthy particles, which adhere to it apparently by a viscous matter; but this appearance may be owing to the peculiar nature of the soil in which it had resided.

Great confusion has existed as to this caterpillar: one writer[7] evidently confounds it with that of the *Sphinx carolina*, which cosmopolite insect is extremely common in New Zealand, as elsewhere, feeding on the Convolvulus batatas, to the great annoyance of the natives, who cultivate that plant for food. This insect, when in the perfect state, is the one referred to by the same writer as attracted by the scarlet flowers of the 'Rata,' flitting from blossom to blossom, seeking the 'honey,' which abounds within them. A wood-boring larva has also been sent from New Zealand as the same as that with which the parasite is connected. These mistakes probably originated through the misinformation conveyed to travellers by the natives.

Among a series of Entomophytes from New Zealand was found the one represented in Pl. II. f. 6; but whether it had been accidentally placed among them for preservation, or had come with them from that country, is unknown. It, however, differs greatly from its companion in the horny shields on the thorax, each segment of which is strongly protected in front by a somewhat crescent-shaped shield; that on the prothorax is the largest, while the other two gradually decrease in size; the one on the metathorax has beneath it on each side a spot of the same kind of horny substance. It may be remarked, that in the formation and position of the shields it approaches very nearly to those seen on the caterpillar of *Hepialus lupinus* of Europe, represented in Pl. II. f. 1. It is probable that the habits and food of this caterpillar are similar to those of the last; but in this case it evidently endeavours to seek the mouth of its perpendicular tube after it becomes affected by the internal germination of the seed of the fungus, which eventually checks its progress when near the orifice, where it remains stationary, after which the external growth of the fungus takes place while the insect is in an upright position, causing it to burst forth apparently through the suture above the labium, and thus it grows on the same plane with the caterpillar. Its growth having taken place in a ready-formed tube, also allows of the free development of the stem, which so increases in thickness as to split the head into two equal parts; while a portion of the fungus, when fully developed, always appears above the orifice, and the end spreads out into a palmated form.

The caterpillar represented in Pl. V. f. 7. was found in Tasmania[8]: the prothorax is almost entirely covered by a horny shield; the mesothorax is furnished with a semicircular shield in front, and a lengthened subtriangular spot of the same horny substance on each side close to the posterior margin; while the metathorax has a moderate-sized subquadrate spot on each side of a less horny substance (Pl. V. f. 8). The caterpillar figured in Pl. II. f. 7. was brought from Victoria, and differs from the former in possessing an additional narrow semicircular shield in front of the metathorax. Another caterpillar is also known to the writer, which is found in New South Wales; but it is only furnished with a semicircular shield on the front of the mesothorax, and with a small subquadrate spot on the side of the metathorax, both of which are apparently of a less horny substance than that which entirely covers the prothorax.

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[1] Ch. Rob. *Végét. Paras.* t. viii. f. 13 (6).

[2] A similar caterpillar has been found perfectly changed into a vegetable substance; but in want of the external fungus, numerous examples of which were dug up in a garden at New Plymouth, New Zealand. —Taylor, *N. Zeal.* p. 424.

[3] *Medical Times*, 1844, p. 200.

[4] Sphæria Hügelii, *Corda*, Icon. tom. iv. p. 44. t. ix. f. 129.

[5] *Journ. Proc. Ent. Soc.* 1836, ii. p. 6.

[6] *Tasm. Journ.* 1849, p. 75.

[7] Colenso, *Lond. Journ. of Bot.* i. p. 304. This gentleman makes the following remark in a letter to Ronald Gunn, Esq.:—"Among other novelties, I have discovered another and very distinct species of vegetating caterpillar, of which, however, I have only hitherto detected two specimens."—*Proc. Roy. Soc. V. D. L.* 1850, p. 301.

[8] An example of which was first discovered by Mr. Gunn in 1832 (*Lond. Journ. of Bot.* vii. p. 572), and numerous specimens were afterwards found in 1846 by the boys, at the back of Mr. Hawkes's Academy, Franklin Village, four miles south of Launceston, V. D. L.—*Tasm. Journ.* 1846, p. 77.

Such variations of the shields are observed in those found on the European species of the genus *Hepialus*. The similarity of their modes of life, however, causes these three caterpillars to become the bases of the same kind of fungoid parasite; and it is probable that these caterpillars are all referable to species of the genus *Pielus*, or of some closely-allied genus[1].

Certain localities of Australia and Tasmania[2] are more favourable for procuring these caterpillars with their parasites than others. The occasional humidity of the country greatly encourages the appearance of this singular fungus[3]; at least, it is always after the tubes have been filled by the heavy rains, which fall in immense quantities[4] at lengthened intervals, that the Entomophytes are found. The caterpillars that become the bases of the fungi vary much in size, reaching in some examples to the length of 4½ inches: this may be considered to show that the caterpillars become possessed of the germ of the parasite at various periods of their age, and that it must be obtained while residing in the burrows wherein they pass the chief portion of their existence, and which they form quite regardless of the nature of the soil, whether it be composed of sand or clay. The tubes are sometimes made to the depth of 2 or 3 feet, and are lined when formed with a coarse web, which greatly facilitates their progress within them; and these tubes are sometimes extended in a horizontal position, while seeking for the various roots that are buried beneath the soil, and which constitute their food. When the caterpillar feels the effects of the inward growth of its enemy, it no doubt, from the position of the plant, which is longitudinal with the insect, seeks the orifice of its perpendicular tube; but it is apparently checked in its progress at a distance from the opening, which distance is shown by the length of the fungus on the different specimens of the Entomophytes, reaching in some examples to a foot or more. After the thallus has filled the interior, the outer portion of the plant invariably bursts forth about the head and prothorax, which two portions are usually covered by the thallus from which the parasite takes its rise; it then appears for about 2 or 3 inches above the earth, ending in a lengthened oval velvety head of an olivaceous black colour; while the stem beneath the ground is white, shadowing off into yellow above it. In some cases two, and in others three fungi take their rise from the same base. It may be further remarked, that the caterpillar is sometimes discovered coated with a white mould; and it may be added, that chrysalides[5] were also found by Mr. Hawkes at Franklin Village, Tasmania, each of which had a fungus growing from it. The germ from which the fungus sprung had probably been taken by the caterpillar before its metamorphosis into the chrysalis state, and the rainy weather happening to set in soon after caused the germination of the seed.

The writer is next enabled to draw attention to a singular kind of Entomophytes[6] (Pl. V. f. 10–12) obtained through the kindness of Mr. Hawkes, who met with it in Tasmania during the month of April last year. It was found in a sandy district, but the exact locality was not mentioned; and, from its appearance, it is not improbable that the mode of life and food of the caterpillar are extremely like those of the New Zealand Entomophytes. It is, however, of a peculiar deep reddish-purple colour, about 3 or 4 inches in length, partaking of the same form as the others; but the shields on the thorax differ. The prothorax is almost entirely covered; the mesothorax has a narrow shield forming a crescent towards the anterior margin, and a subtriangular shield on the side next the posterior margin; the metathorax is only furnished with a very narrow crescent-shaped shield and a subquadrate spot on the side (Pl. V. f. 12).

This parasite also bears a great similarity to those of New Zealand, and from its manner of growth one is induced to suppose that the external plant also forces its way at once through the sandy soil, wherever the insect may happen to be situated in its burrow when overtaken by the effect of the internal development of the thallus. Judging from the various lengths of the plant, this takes place at different depths from the surface; and it is sometimes evident that the two ends of the caterpillar, when so affected by parasites, are buried at unequal depths. Thus the plant emerging at the anal portion in one example was apparently buried for 3½ inches, while that originating at the anterior part was not buried for more than 2½ inches, showing a difference of 1 inch between the two ends, and at the same time proving the justice of the opinion previously expressed in reference to the New Zealand Entomophytes, that the plant takes its rise from the caterpillar while in a horizontal or nearly horizontal position. The specimens in general show that the stem above the surface (*i. e.* between the earth and the fructification) did not exceed a half or a quarter of an inch in length; and the buried portion of the stem, it may be remarked, especially that nearest the surface, is covered with a quantity of fulvous woolly matter, which matter sometimes extends itself on the body of the caterpillar.

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[1] Five species are mentioned by Mr. Walker in the *List of Lepid. Heter.* vii. p. 1576. The third caterpillar referred to above is probably that of *P. atripalpus*, Walk. *List of Lepid. Heter. B. M.* vii. p. 1577.

Mr. Breton exhibited "specimens of the moth of the caterpillar which bears the peculiar fungus," before the Tasmanian Society in 1848 (*Tasm. Journ.* 1848, p. 408); but it does not appear that the specific name of the insect has been recorded.

[2] Melbourne and Hunter's River; but it is in the neighbourhood of Launceston, V. D. L., that the greatest number of specimens have been found.

[3] Sphæria or fungoid caterpillar, *Gunn*, Tasm. Journ. 1846, p. 77.

Sphæria (Cordyceps) Gunnii, *Berkel.*, Hook. Journ. of Bot. 1848, p. 578. pl. 22.

Clavaria crassa, *Maudsley*, Proc. Roy. Soc. of V. D. L. 1851, ii. p. 149.

[4] The fall of rain on one occasion in Tasmania during February 1854 was equal to 8¾ inches in thirty-eight hours.

[5] *Proc. Roy. Soc. V. D. L.* 1853, p. 320. The unaffected chrysalis is represented in Pl. II. f. 8 of this pamphlet.

[6] Should this parasite be new, it might with propriety be designated Sphæria (Cordyceps) Hawkesii, as a fitting companion to S. Gunnii, Robertsii, Sinclairi, and Taylori.

The most curious feature, however, of this parasite is, that it grows from various portions of the body of the caterpillar, and in this respect offers a great difference from that of the New Zealand kind. Various examples of this distinction are among the specimens sent by Mr. Hawkes to the British Museum; one is represented (Pl. V. f. 10) exhibiting two fungoid tubercles forcing their way through the head, two fungi growing from the same base on the side of the abdominal segments, and a short fungus proceeding from the anal segment posteriorly. Another specimen is given (Pl. V. f. 11), which was apparently in the act of progressing head upwards, but which had been checked in its progress, and the fungus had thus grown from both its ends; yet the two plants had appeared above the surface of the earth, near to each other: that from the head is about $5\frac{1}{4}$ inches, while the one from the anal portion is $8\frac{1}{4}$ inches in length; the latter, however, proceeded from a short stem which had first, apparently, grown downwards before the plant turned towards the surface. The stem is irregular in its length, and in places is very woolly, especially the part near the surface, and is more so on the one from the head. Some of these caterpillars bear a fungus composed of a short stem at the base, which has evidently been broken, and has then given origin to several branches; these branches are more slender than where the plant consists only of a single stem throughout. The discovery of this species of parasite has dispelled the idea which had been entertained up to the present time, that *Sphæria Gunnii* was the only one to be found in Tasmania. A similar one, or perhaps the same species, is also found in Victoria.

The caterpillar may be that of a species of *Pielus*, or of some closely-allied genus; but the perfect insect is unknown at present.

The remarkable large caterpillar found in the neighbourhood of the River Murrumbidgee, New South Wales (probably also found at Murray River, Port Macquarie), may ultimately prove to be a species of the same family; but it is to be regretted that no opportunity has occurred for carefully examining an example.

The caterpillars of these Entomophytes, each of which measures some 6 inches in length, were found in a rich black alluvial soil; and nearly thirty examples were secured by Mr. Allen during March 1837[1]. Attention was directed to them in consequence of the ground being perforated in many places: from some of the tubes were seen emerging numerous pupa-cases, and from others these Entomophytes, partly projecting above the surface of the earth. Many of the pupa-cases were open, as if the insects had performed the last act of their transitional life, *i. e.* throwing off the pupa-case or last skin, before appearing in their aërial condition. The perfect insects afterwards showed themselves as night approached, and became extremely troublesome to travellers by flitting about their lights; on obtaining one, it proved to be a large "brown moth," which may turn out to be an undescribed, though known, species of *Pielus*, or of an allied genus. The female measures, in expanse of wings, nearly 10 inches, while the male is rather less.

This parasite[2] is, however, totally different from any of the others in the manner of its growth: it has a very thick stem, which is apparently "formed by the close union of several stalks[3]," having the apical portion distinctly divided into a series of short irregular branches, "of a brown velvety texture[3]." The anterior portion is just seen above the surface at the orifice of the tube, and affords the means of discovering it. The basal part of the parasite is apparently forced through the front of the head of the caterpillar. These latter portions are hidden within the perpendicular tube which the caterpillar had originally made, causing the plant to be on the same plane with the insect, which accounts for the peculiar manner of growth of the fungus.

To this family belongs the *Cossus ligniperda*[4], the caterpillar of which was found by Mr. Bond in England in a burrow that it had formed in a tree, wherein it was attached by one side of its body to the surface of the tube by means of a mass of white cottony mould. The mould also extended partly round each segment, and appeared through the spiracles of the unattached side of its body, and also through the false feet, showing that the interior of the body was completely filled with it; but the body was somewhat contracted.

The caterpillar of this insect always resides in the trunks of trees, such as willows, oaks, and elms, feeding on the wood, and at the same time perforating it in all directions. The number of burrows which these insects make during the period of three or four years that they are stated to live greatly weakens the trees, so that they are sometimes blown down by the wind, or they even fall by the weight of the top part of the tree. When the caterpillar is about to pass into a chrysalis, it seeks the entrance of its burrow, where it is surrounded with a cocoon composed of pieces of rotten wood glued together, a portion of which always remains apparent from the entrance, so that the perfect insect, after a time, may easily make its escape[5].

Two Indian caterpillars are represented by the Rev. Mr.

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[1] Taylor, *Tasm. Journ.* 1842, p. 308. fig. ; *Lond. Journ. of Bot.* 1842, ii. p. 210. pl. viii.; Thompson, *Medical Times*, 1844, p. 200.

[2] Sphæria Taylori, *Berkel.* Lond. Journ. of Bot. ii. p. 209. t. 8. f. 3; Ch. Rob. *Végét. Paras.* p. 619; Taylor, *New Zealand*, p. 423, fig. p. 425.

Sphæria innominata, *Taylor*, Tasm. Journ. i. p. 308. pl. . f. 2 (1842); Thomps. *Medical Times*, 1844, p. 200. fig. .

[3] *Tasm. Journ.* i. p. 308.

[4] Walk. *List Lepid. Heter. B. M.* vii. p. 1511.

[5] A wood-boring caterpillar has been mentioned by Mr. Hawkes n letter in the following terms:—"The grub so destructive to the wattle-trees in Tasmania has also been found converted into a fungus, the growth of which has been two or three feet, filling the channel the grub had made through the heart of the tree in the process of boring." This may be the grub of which Mr. Milligan mentions having picked up the

Berkeley as having parasitical fungi[1] growing from their heads; these were found by Drs. Hooker and Thomson at Myrong. It must be remarked that the figures of the caterpillar are not sufficiently characteristic to make out exactly whether they belong to this family or not; the manner of growth of the plants, however, induces the supposition that their habits, especially those of the caterpillar which bears the *Cordyceps falcata*, most probably accord with those that have been previously given, and therefore they may also be species of the same family.

The chrysalis represented in Pl. III. f. 6, which no doubt belongs to the family *Notodontidæ*, is remarkable for being armed with hooks on the anal projection, each of which is bifid near the end, which character points it out as belonging to *Phalera bucephala*[2].

The caterpillar of this insect undergoes its metamorphosis into the chrysalis state during the month of September, when it buries itself, without any cocoon, near the surface among the decayed leaves and moss in damp woods, where it awaits the period for its transition into the perfect state. While thus buried, some of the chrysalides, during wet seasons, form the bases of the parasite, the germ of which had probably been conveyed into the interior of the caterpillar previous to its undergoing its metamorphosis. The plant does not make any external appearance until after the interior of the chrysalis-case has become completely filled with the thallus; it usually bursts forth in the form of a club-shaped fungus[3], and takes its rise from the sutures between the various cases that separately cover the wings and antennæ, &c.; these together compose the anterior part of the chrysalis.

In Pl. III. f. 5.[4] is given a figure, which represents a great variation in the manner of growth; viz. the anterior portion of the chrysalis is covered with a mass of thallus, from which proceeds a series of slender roots spreading in various directions, while anteriorly it has two fungi with club-shaped heads growing from the apex of the thallus. Such examples are stated to be found in the autumnal months. It is supposed that the caterpillars represented in Pl. III. f. 8, 9. may belong to the same species. Though in a great measure filled with the thallus, yet they present a wrinkled appearance, while the parasite afterwards makes its way through the joint between the head and prothorax. They had probably buried themselves among decayed leaves or moss, with the intention of undergoing their metamorphosis into the chrysalis; but this transition was hindered by the internal development of the parasite having proceeded too far to allow of the change taking place. Two figures (Pl. III. f. 1, 2[5]) are also subjoined, representing the parasite growing on the surface of each segment; this peculiar manner of growth is especially shown in f. 2, where numerous fungi are proceeding from the different segments of the caterpillar under the same circumstances. Such an example has not been met with in any collection.

To the family *Bombycidæ* must be referred the caterpillar of the *Lasiocampa rubi*[6], which has been found in France subject to parasites[7]. The insects usually appear towards the end of summer and beginning of autumn in woody plains and extensive heaths, feeding on the bramble. They conceal themselves throughout the winter among the large plants (under the leaves of which they are protected from the severity of the winter), where they await the arrival of spring, when they undergo the change into the chrysalis, and it is not until the end of May or beginning of June that they assume the perfect state. It is found to be very difficult to rear these caterpillars through their different stages of existence while in confinement, as most of them die and become the bases of fungi[8]. Others, in the middle of March, are discovered more or less enveloped by a whitish down or mould[9], which fungoid mould is even found on some caterpillars while in a living state, when it generally appears on several of their segments, and on the anal segment particularly. These caterpillars after a short time become immoveable, and eventually die, either straight or slightly curved. The body, however, keeps its usual bulk, and attains a singular firmness, while at the same time the fungoid mould makes rapid progress, completely covering the body, and scarcely leaving the long hairs visible.

The well-known *Bombyx mori*[10], the silkworm, which also belongs to this family, is liable to become, during various

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skin, distended with the fungus-like substance characteristic of the parasite, in a grove of young wattle-trees on the eastern side of the Windmill Hill, near Launceston (*Proc. Roy. Soc. V. D. L.* 1852, p.149). The writer has since been informed by Mr. Bakewell, that the caterpillar which is so destructive to the wattle-trees is that of *Zeuzera liturata**. It is extremely common in many parts of Australia, where it is much sought after by the natives, who devour an immense quantity of them, as a favourite article of food.

[1] Cordyceps racemosa, } *Berkel*, Hook. Journ. of Bot. n. s. vi. p. 212.
—— falcata, } pl. 8. f. 2, 3.

[2] Walk. *List Lepid. Heter. B. M.* v. p. 1050.

[3] Clavaria militaris, *Müll.* Flor. Dan. t. 659; Holmsk. *Coryp.* t. 15. f. *a*, *d–g*, *i*, *k*.; Ch. Rob. *Végét. Paras.* p. 667; *Journ. Proc. Linn. Soc.* i. p. lxiv (Devon, 1855).
Xylaria militaris, *Gray*, Nat. Arrang. Brit. Pl. i. p. 510.
Kentrosporium militare, *Walbr.* Beitr. zur Bot. t. iii. f. 18–21.
Sphæria (Cordyceps) militaris, *Berkel.* Eng. Flor. p. .

[4] Müll. *Nova Acta Acad. Nat. Cur.* iv. p. 215. t. 7. f. 5; id. *Journ. de Phys.* 1771, i. p. 151. t. 2. f. 5.

[5] Holm, *Acta Hafn.* 1781, i. p. 289. t. . f. viii. ix.

[6] Phalæna Bombyx rubi, *L.*, Walk. *List of Lepid. Heter. B. M.* vi. p. 1429.

[7] Tulasne, *Ann. des Sci. Nat., Bot.* 1857, p. 36.

[8] Sphæria militaris.

[9] This mould possesses, says M. Tulasne, many characters attributed to certain species of Botrytis, and especially all those which distinguish the B. Bassiana, *Bals.—Ann. des Sci. Nat., Bot.* 1857, p. 38.

[10] Walk. *List Lepid. Heter. B. M.* vi. p. 1505.

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* Walk. *List Lepid. Heter. B. M.* vii. p. 1540. There are also three or four other caterpillars, of allied species, that are equally found in Australia; these also probably bore into, and feed on, the same kind of tree, and may therefore become similarly affected.

periods of its growth, suddenly torpid and stationary; this, it is proved, is caused by the caterpillar having by some means come in contact with the infinitely minute germ of the parasitical mould termed Muscardine[1], or *Botrytis bassiana*[2], "the seeds of which," says the botanist, "are very numerous, and so minute that they only become visible when aggregated in masses of thousands together; and they exist everywhere suspended in the air[3]," and may then no doubt adhere to leaves and other objects, and thus find their way with the food into the interior of the caterpillar, where, during some humid seasons which occasionally happen in spring and autumn, the germination of the parasite takes place with great rapidity, filling the interior; and thus eventually "the vital organs are clogged up" by it, and the caterpillar becomes still. While in this state, the mould soon shows itself on the exterior surface[4] in the form of a "white efflorescence, which is the fructification[5]," having, when matured, a series of spores at the apex of each filament, some of which apices are acute, while others are dilated[6]. Before, however, the outer skin is completely covered, the insect dies, when the body, being filled internally and coated exteriorly, becomes so firm and hard that it easily breaks into two pieces when bent. In some seasons, which from their humidity are favourable for the development of the parasitic mould, the entire crop of domesticated silkworms is rapidly destroyed by this parasite, as if by contagion; when this occurs, it occasions a heavy loss to the rearers of the caterpillars for the purpose of collecting the silk. The chrysalides[7] are not subjected to the same kind of parasite, except when occasioned by artificial means.

Another kind of fungoid parasite also affects the silkworm, which first made its appearance in France, where it became very common, in 1845; after which it appeared in Italy and Spain in 1854, and has now extended itself into Switzerland and South Germany. It appears that the caterpillars are not affected by it until after the second casting of the skin; and many perish without any external appearance to the naked eye of being so attacked. On the caterpillar assuming the third or fourth skin, it becomes weak, and of a greyish colour, after which the insect gradually dies by the progress of the fungus; and the caterpillar then assumes a dusky yellow colour, which pervades the whole system, with some brown or black spots which are formed by the concentration of a series of fungoid tubercles. Some caterpillars, however, live sufficiently long to form their cocoons; after which, a part die, while others live long enough to transform into the chrysalis, and a few even undergo their metamorphosis into the perfect state. Should they, however, attain this last state, they always appear with their wings crippled; these organs, with the antennæ, legs, and body, show signs of black spots, around and in which is found a fungoid parasite[8]. It is further thought that after they have reached the perfect state they are capable of propagation, and thus the disease[9] becomes hereditary. This fungoid disease is not thought to be conveyed to the insect by the brown spots which are sometimes found on the leaves of the mulberry-tree (though these spots occur about the same time), as they exhibit quite another kind of parasite

Caterpillars of Nocturnal Lepidoptera[10] have sometimes been found in this country, during years of extreme dampness, attacked in a similar manner to the silkworm as first recorded, as if by the same kind of parasite. "It is by no means," says Mr. Bond, "uncommon to see caterpillars in this state in various parts of the New Forest: they are, at the same time, usually surrounded by cobweb, as if a spider had wished to secure them; but whether this is done after the caterpillar becomes coated or not must remain for future observation. It is certain, however, that it is always after very wet seasons that these fungoid caterpillars are discovered." It was under such circumstances that Mr. Bond found the caterpillar (Pl. V. f. 5) of *Odenestis potatoria*[11], which belongs to the same family as the silkworm, thickly covered by a white creamy fungoid matter or mould all over its body, almost concealing the hairs that clothe its surface, as well as its feet.

To the family *Lithosiidæ* belongs the *Callimorpha jacobææ*[12], the caterpillars of which are clothed with short hairs, and are of solitary habits, feeding on the flowers of the Ragwort, and while thus engaged are subject, during very humid seasons, to become the bases of *Isaria floccosa*[13]. This parasitical mould no doubt commences internally, and afterwards progresses externally, like that which grows on the Sphingides, &c. The chrysalis is only enveloped in a slight kind of cocoon, and has been recorded to have been found covered by the same kind of mould, which had probably come in contact with the caterpillar when on the point of undergoing its metamorphosis.

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[1] Bassi, *Lettr. Prop. de l'Industr. de la Soie*, 1835, p. 193.

[2] Balsamo, *Gazst. de Milan*, 1835, p. .

[3] *Penny Cyclop.* 'Fungus.' It is also stated in this article, that the seeds sometimes fix themselves upon live insects, producing great havoc among the silkworms.

[4] Ch. Rob. *Végét. Paras.* t. 3. f. 2.

[5] *Penny Cyclop.* 'Dry-rot.'

[6] Ch. Rob. *Végét. Paras.* t. 3. f. 3, 4.

[7] Berkel. *Hook. Lond. Journ. of Bot.* ii. p. 209.

[8] Panhistophyton ovatum, *Lebert*, Berl. Entom. Zeit. 1858, p. 149.
Nosema bombycis, *Nägeli*.

[9] Professor Lebert has designated it under the name of *Dystrophia mycetina*. In France it is known as 'Etisie,' 'pattes noires,' or 'poivre,' and in Italy as 'Gattina,' while M. de Quatrefages calls it 'Maladie de la Tache;' and he also mentions that silkworms fed on leaves sprinkled with scraped sugar throve well, and spun their cocoons sooner than the others, even after they began to shrivel up and diminish in size. In *Report* of MM. Decaisne, Peligot and Quatrefages to the Acad. des Sci. It is stated by Liebig, that "in pure sugar-water the seeds of parasitic plants disappear during fermentation."—*Ann. & Mag. N. H.* 1841, p. 404. May not some chemical action of this kind take place in these insects, and thereby the seeds or spores become checked in their development?

[10] *Journ. Proc. Ent. Soc.* ii. n. s. p. 132.

[11] Walk. *List Lepid. Heter. B. M.* vi. p. 1410.

[12] Walk. *List of Lepid. Heter. B. M.* ii. p. 573.

[13] Fries, *Syst.* iii. p. 274; Ch. Rob. *Végét. Paras.* p. 607.

From the appearances exhibited by the caterpillar represented in Pl. III. f. 10, it is supposed to belong to this family. It was found at Bulstrode in Buckinghamshire, and had probably, while feeding on the low-growing plants, come in contact with the germ of the parasite[1]. The caterpillar would seem afterwards to have buried itself among the damp vegetable debris, apparently to the depth of an inch and a half; while thus located it germinates, and the parasite grows from it, having the basal half of the lengthened stem furnished with short slender roots proceeding from various parts with in that length,—while the apical portion is smooth and without any such appendages, which shows that it was exposed above the surface of the earth. The apex terminates in a small globular head. The parasite grows from the thorax, which is completely covered by the thallus. The body of the insect has minute roots springing from it.

The caterpillar which is from the East Indies, and represented in Pl. III. f. 3[2] twice its natural size, is apparently furnished with slender hairs all over its body, and with short fascicles of hairs along each side, as well as with four fascicles of long strong hairs placed two anteriorly and two posteriorly, leading to the supposition that it may belong to the family *Liparidæ*; but further information cannot be given, as the parasite so completely covers the caterpillar as to obliterate all those minute specific characters which might assist in determining its name.

The caterpillars of this family, it may be observed, are usually hatched in April; and consequently they remain in that state until the month of June, when they change to the pupa: from this latter state they do not change to a moth until towards the end of July.

The parasitical mould had no doubt commenced as usual in the interior of the caterpillar, and then covered the exterior; after which a series of lengthened filaments grew from the upper surface of the body. It is probably a species of *Isaria*, though M. Robin considers the structure of the plant to be like that of "*Sphæria entomorhiza.*"

In the great family of *Noctuidæ* must be placed the caterpillar of the far-famed Chinese "Summer-plant Winter-insect"[3] (Pl. III. f. 13), which exhibits, amongst other characters, that of having the prothorax entirely protected by a shield, and from its general appearance seems to form part of the genus *Gortyna*[4]. The caterpillar, which is of a light yellowish-brown colour, probably bores into and feeds on the roots of aquatic plants that grow abundantly in the marshy ground on the sides of the numerous rivers and canals of China[5]; and they are also stated to be brought from Japan[6] and Thibet. The insect can only be discovered by the appearance of the plant, which, soon after it is attacked, begins to droop and look sickly. After the parasite comes in contact with the caterpillar, the latter buries itself in the earth: it first turns with its head upwards; and then, being apparently checked by the presence of the parasite internally, it remains in that position, and the outer plant[7] naturally grows upwards and breaks its way out, probably through the suture of the labium. As it increases in size, it splits the head into two parts, as is shown in the figure. Like the others that grow in the same manner, the stem is thick throughout, with the apex somewhat flattened and rather broad, so much so as to be palmated[8] in some specimens.

Réaumur[9], who in 1726 first published a notice of this curious fungoid insect, stated that the parasite was attached to the anal portion of the caterpillar; and he represented that when the parasite was detached from the insect, the end gave the appearance of lengthened roots, as if they had surrounded the last segment of the body of the insect. The parasite, however, springs from the head; and the Rev. M. J. Berkeley says[10] "that it is attached by simple, or very sparingly-branched, very slender, flexuous, inarticulate threads, which spread more or less over the surface of the caterpillar. The substance of the caterpillar is replaced by a rough mass of very fine branched threads which are far more compact than those in the substance of the fungus, mixed with colourless oil-globules."

The caterpillar of the *Eurois tincta*[11] (Pl. V. f. 9) was found, in some part of Kent, perfectly free from any appearance of having a parasite upon it, and was conveyed to a breeding-cage in London to undergo its metamorphosis, but was discovered some time afterwards completely filled with a fungoid substance, and at the same time exhibited two long very slender parasites, which grew from the back of the thoracic segments. Another caterpillar of this family was obtained in the autumn of 1843 from off palings, to which it had apparently been attached by a spider's-web, and thus it was kept exposed to the influence of the weather. Its body was entirely coated by a white creamy mould, like that which attacks silkworms, and is termed Muscardine; the insect is so completely filled, that even the feet, especially the false ones, are fully stretched out by the internal thallus.

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[1] Sphæria entomorhiza, *Dicks.*

[2] Ch. Rob. *Végét. Paras.* t. ix. f. 6.

[3] Pereira, *Pharm. Journ.* ii. p. 590.

[4] The late Mr. Doubleday considered that it was probably a species of *Agrotis*.

[5] Where it is stated to be "used only in the Emperor's palace, as a strengthening and renovating substance, and is supposed to possess properties similar to those ascribed to ginseng. It is recommended in cases where the powers of the system have been reduced by over-exertion or sickness. A duck is stuffed with five drachms of the fungus, and the bird roasted by a slow fire. The virtue of the fungus is supposed to pass into the flesh of the bird, which is to be eaten twice daily for eight or ten days."—Pereira, *Mat. Med.* ii. p. 52. f. 43, 44.

[6] Where it is known as 'Totsu kaso.' Thunberg, *Trav.* iii. p. 68.

[7] Clavaria entomorrhiza, *Westw.* Journ. Proc. Ent. Soc. 1838, p. vi, et 1841, pl. vi. f. 5; Ch. Rob. *Végét. Paras.* p. 663; Pereira, *Pharm. Journ.* ii. p. 591, fig. p. 592.

Sphæria sinensis, *Berkel.* Lond. Journ. of Bot. ii. p. 207. pl. viii. f. 11 *a–d*; Lindley, *Veget. Kingd.* p. 39. fig. xxiv.*; Ch. Rob. *Végét. Paras.* p. 648; Pereira, *Mat. Med.* ii. p. 52. fig.

[8] *Lond. Journ. of Bot.* ii. pl. viii. f. .

[9] *Mém. Acad. Roy. des Sci.* 1726 (1728), p. 304. t. 16. f. 1–4; Fougeroux, *l. c.* 1769, p. 472. t. 5. f. 10, 11.

[10] *Lond. Journ. of Bot.* ii. p. 207.

[11] Walk. *List Lepid. Heter. B. M.* xi. p. 553.

Various European chrysalides of this family are also occasionally found infested by parasitical moulds. Thus, the chrysalis of the *Tæniocampa instabilis*[1] has been obtained attacked by the *Isaria leprosa*[2], and that of the *Hama upsilon*[3] with the *Isaria strigosa*[4]. A half-rotten chrysalis, which had been found in a shady place, was covered by the *Isaria crassa*[5]; and another chrysalis formed the basis of a parasite which has been called *Isaria velutipes*[6]—this parasite is considered by some botanists to be a variety of the former one. The chrysalis, Pl. III. f. 4[7], in a partly-opened cocoon which is supposed to be formed so by a species of *Mamestra* ?, had the *Clavaria militaris* growing on it, while Pl. III. f. 7. represents an entirely close kind of cocoon, from which grows a palmated kind of fungus that has been designated *Ramaria farinosa*[8], and is stated to be found in Sweden and England. The parasite proceeds from the chrysalis through the surface of the cocoon, which is composed of particles of earth matted together by silk.

Perfect insects of the same family are equally infested with parasitical moulds, viz.,

Erebus odora[9], from Ega.
Erebus odora, var., from St. Domingo (Pl. III. f. 12), attached to a leaf.
Plaxia macarea[10], Cram. t. 399. f. L, from Surinam.
Cerastis vaccinii[11], of Europe.

And also undetermined species of British *Noctuæ*, viz., one found in Devonshire attached to a leaf (Pl. III. f. 14); another in St. Mary's Isle, Kirkcudbright, attached to a branch of a tree (Pl. III. f. 15); and a third from the New Forest, also attached to a branch of a heath.

These imago insects are all apparently infested by the same kind of *Isaria* as that which has been previously noticed and described as growing on the species of *Sphingidæ*, and are attached to leaves, &c., under similar circumstances. The last example mentioned was discovered surrounded by a cobweb, as if the spider had enveloped it to secure it; but whether before or after the growth of the parasite is uncertain.

Several European species of *Geometridæ* are recorded as having been discovered with the *Isaria arachnophila*[12] upon them, viz. *Geometra* (Speranzia) *brunneata*, *G.* (Eraunis) *defoliaria*, *G.* (Nyssia) *zonaria*, *G.* (Biston) *betularia*, *G.* (Oporabia) *dilutaria*; and the pupa of *G.* (Bupalus) *piniaria* has been found covered with a fungoid mould[13].

A species of *Tinea* from St. Domingo is contained in the British Museum, which is affixed to a leaf by means of a species of *Isaria* in the same manner as the *Sphingidæ*, &c.

Pl. III. f. 11. represents (twice its natural size) a small caterpillar from St. Vincent, having lengthened slender fungi, with long clavate apices, growing from the upper surface of the thoracic segments, while from beneath the abdomen sprout various short fungi of different lengths and forms. The characters of the insect are so obliterated by the fungoid matter, that it is impossible to give any idea of its position in the system. The Rev. Mr. Berkeley has recorded that in South Carolina were obtained, during summer, certain small "caterpillars" that were buried in the soil in damp woods. From the head of each grew a long slender fungoid parasite[14], which reached to the length of 4 inches. But not having seen the specimens, it is impossible from the figures to form any opinion as to the family of *Lepidoptera* they may belong to.

In ORTHOPTERA only one species has as yet been noticed as attacked by a fungous parasite. A specimen of *Gryllotalpa americana* was found in a wood "near Newark, Delaware, upon turning over a log. The insect was seen standing very quietly at the mouth of its oval cell, which is formed in the earth, having a short curved tube to the surface. Upon taking it up it exhibited no signs of movement, though perfectly fresh and life-like in appearance." On examining it the next morning, "it still presented no signs of life. Every part of the insect was perfect, not even the antennæ being broken. Upon feeling it, it was very hard and resistant; and on making an incision through the thorax, it exhaled a fungoid odour. The insect had been invaded with a parasitic fungus, which everywhere filled the animal, occupying the position of all the soft tissue, and extending even into the tarsal joints. It formed a yellowish or cream-coloured compact mass, and, in the abdomen, enclosed in its centre the stomachal teeth of the insect[15]." This fungus is thought by Dr. Leidy[1] to be the same as that which sometimes attacks the larvæ of lamellicorn insects.

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[1] Noctua instabilis, *Schiff.*; Walk. *List Lepid. Heter. B. M.* x. p. 424.

[2] Fries, *Syst.* iii. p. 272; Ch. Rob. *Végét. Paras.* p. 608.

[3] Noctua upsilon, *Schiff.*; Orthosia ypsilon, *Walk.* List Lepid. Heter. B. M. x. p. 433.

[4] Fries, *Syst.* p. 274; Ch. Rob. *Végét. Paras.* p. 607.

[5] Link, *Spec.* ii. p. 122.
Isaria farinosa, *Fries*; Ch. Rob. *Végét. Paras.* p. 608; Kirby and Spence, *Introd. to Ent.* iv. p. 207.

[6] Link, *Observ. in Ord. Plant. Nat.* i. p. 18. t. 1. f. 32.
Isaria crassa, var., *Ch. Rob.* Végét. Paras. p. 609.

[7] Holm, *Acta Hafn.* 1781, i. p. 302. t. . f. x; Holmsk. *Coryp.* t. 15. f. *b*, *c*, *h*.

[8] Holm, *l. c.* i. p. 299. t. . f. vi.; Holmsk. *Coryp.* t. 7; Ch. Rob. *Végét. Paras.* p. 670.
Clavaria farinosa, *Dicks.*
Isaria truncata, *Pers.*; Kirby and Spence, *Introd. to Ent.* iv. p. 207.

[9] Walk. *List of Lepid. Heter. B. M.* xiv. p. 1290.

[10] Walk. *l. c.* xv. p. 1626.

[11] Walk. *l. c.* x. p. 446; Lebert, *Berl. Ent. Zeit.* 1858, p. 179.

[12] Dittmar, in *Sturm*, *Germ.* iii. t. 55; Ch. Rob. *Végét. Paras.* p. 607.

[13] A species of Verticillium, *Lebert*, Berl. Ent. Zeit. 1858, p. 179.

[14] Cordyceps acicularis, *Ravenel*, Berkel. *Journ. of Proc. Linn. Soc.* 1857, p. 158. t. . f. .

[15] Leidy, *Proc. Acad. Nat. Sci. Philad.* 1851, pp. 204, 210; id. *Smithsonian Contr. to Knowl.* v. p. 53.

Among HYMENOPTERA several families have to be referred to: viz., in the family *Chrysididæ* must be noticed a new species of *Chrysis* from Celebes, having very minute parasites, which proceed from various parts of the thorax and abdomen, in the form of very minute, slender, semitransparent filaments, with rounded heads at the apex of each, of a yellow colour.

These insects are usually found in holes in rotten wood which had been occupied by other insects, on which they in their turn are parasitic.

A species of *Pemphredon*[2], which forms part of the family *Crabronidæ*, has been observed in this country attached to plants by a similar secretion to that which affects the common fly, as noticed under Diptera.

Three species of the family *Formicidæ* have been discovered as infested with fungoid parasites: viz., a species of *Formica* from St. Vincent (represented Pl. IV. f. 7) is attached to a leaf by means of a fungoid matter, while from between the hind part of the thorax and the fore part of the abdomen proceeds a very slender filament. In a second specimen, also attached to a leaf, a very long slender fungoid filament takes its rise from between the head and prothorax. The *Formica atriceps*[3] from Santarem has a rather thick stem-like fungus from between the thorax and head above, which looks as if it were imperfect. And a specimen of the *Formica sexguttata*[4], from Santarem, which is attached to a portion of a leaf by its abdomen and legs, bears, from the front of the head above the labium, and from the prothorax, two slender filiform fungi; that of the latter is branched from the middle of its length, the ends gradually becoming very acute and hair-like.

These insects, as neuters, reside chiefly in the nest, which they form under ground, and wherein they perform all the labour of the community.

In the family *Eumenidæ*, it may be mentioned that the *Odynerus parietum*[5] has been found by Mr. F. Smith in Battersea Fields, having a fungus growing from the front of the prothorax.

To the family *Vespidæ* belong several insects subject to parasites; the first is the well-known Hornet, or *Vespa crabro*[6] (Pl. IV. f. 8), which was taken out of rotten wood during summer, having attached to the under surface of the thorax and abdomen a series of filiform fungi[7], measuring from 2½ to near 4 inches in length, gradually becoming acute at the tip, while at an inch from the base is a knot-like projection, from which the remaining portion of each of the stems seems to spring.

The hornet forms its nest, which is composed of decaying wood, in hollow trees, or under the eaves of barns, &c.

The *Polistes americana*[8] has been recorded as apparently attacked by three kinds of fungi. That first to be noticed was described by Felton in 1764 under the name of *Vespa crinita*[9], or "the wasp with hairs." It was furnished with very long and extremely slender filaments that proceeded from the various sutures of the head and thorax, and from the joints of the abdomen and legs. They are of various lengths, being longest on the head, thorax, and abdomen. Felton says that "all the hairs are of a light brown colour, and seem to be stiff; but their ends are quite soft, like papillæ, and from thence thicker." These are sometimes, it is said, found in clusters of many individuals matted together.

The second example (Pl. IV. f. 2[10]) is attached longitudinally to a branch by means of the tarsi; it wants the wings, although it is in the imago state. The parasite proceeds from the joints of the upper surface of the thorax and abdomen, in the form of numerous slender filaments from two lines to three-quarters of an inch in length. The thorax and abdomen are black, except at the tip of the latter, which is red, while the plant is of an orange colour. It is stated by M. Saussure to be brought from the Antilles and Cayenne. The third example (Pl. IV. f. 6) is from the West Indies, where it is known under the name of "la Guêpe végétale," or Vegetable Wasp. The parasite protrudes from the sternum; and "the wasp" was noticed by Dr. Maddiana still living[11] with its encumbrance attached to it, though apparently in the last stage of existence, and seeming about to perish from the influence of its destructive parasite[12].

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[1] *Proc. Acad. Nat. Sci. Philad.* 1851, p. 235.

[2] Diodontus, *Steph. Journ. of Proc. Ent. Soc.* ii. p. lxiv (1837).

[3] Smith, *List of Hymenopt. Ins. B. M.* vi. p. 44.

[4] Smith, *List of Hymenopt. Ins. B. M.* vi. p. 41.

[5] Smith, *List of Hymenopt. Ins. B. M.* v. p. 52.

[6] Smith, *List of Hymenopt. Ins. B. M.* v. p. 116.

[7] Isaria spheoophila, *Dittmar*, in Sturm, *Germ. Flora*, t. 57; Ch. Rob. *Végét. Paras.* p. 609.
Ceratonema crabronis, *Pers.* Myc. t. 48.

[8] Polistes americana, *Fabr.* Syst. Piez. 275. 29; Saussure, *Monogr. Guêp. Soc.* p. 93.
Polistes crinita, *Smith*, List of Hymenopt. Ins. B. M. v. p. 108.

[9] Vespa crinita, *Felton*, Philos. Trans. liv. p. 54. pl. vi.; *Naturforscher*, v. p. 194. t. ; Fuessly, *Mag. der Entom.* ii. p. 97; Saussure, *Monogr. Guêp. Soc.* p. 93.

[10] Saussure, *Guêp. Soc.* p. 93. t. xi.

[11] This singular phenomenon was first noticed by Torrubia, in his *Apparato para la historia natural de Espannola*, 1754, who gave a representation of two wasps lying on the ground, with a tree growing out of the base of each abdomen, while three other wasps are *flying* round the trees that are growing from the ground, having a similar tree affixed to each insect. Each tree is furnished with numerous trifoliated leaves. (Copied in Edw. *Birds*, pl. 336; Buchner, *Nova Acta Cur.* 1767, t. 7. f. 13; *Der Naturforscher*, 1774, t. iv.)

[12] Sphæria entomorrhiza, *Halsey*, Ann. Lyc. of New York, 1823, p. 125.
Sphæria militaris, *Penny Cyclop.* 'Dry-rot.'
Clavaria militaris, *Berkel.*
Polistophtora anthyllarum, *Lebert*, Berl. Ent. Zeit. 1858, p. 179.

In another account[1] it is stated that "a wasp's nest" was found "lying on the ground, which had by some means been separated from a branch of the *Laurus persea*, near which it had fallen. The insects were in a strange condition after this disaster to their dwelling. Some were flitting about over the cells, and by the softness of their wings and the faintness of their colours were easily known to have undergone the last metamorphosis into the perfect insect but a short time." "Many others were lying dead on the ground. On examining these, it was instantly perceived that vegetables were proceeding from their bodies, and this uniformly from the anterior part of the sternum or thorax." Fifty specimens were collected of the vegetating wasps. "On inspecting the nest, it was found that a considerable portion of the cells were empty. This, however, was not the case with them all; for there were still some that contained young wasps in the state of larvæ [pupæ], and which had not reached the last stage of the metamorphosis." One of these was drawn from its cell, and was found to have an incipient vegetation; and, moreover, its progress had kept pace with the growth of the chrysalis [pupa]. It is rarely, if ever, found with more than one plant on an insect. The entire body of the insect is found, on being opened, to be filled with the thallus of the fungus, which dries up the interior of the body, and then by degrees occupies the whole cavity of the shell of the insect, even "to the orbits of the eyes and the joints of the tarsi[2]." The nest of this insect is composed of finely gnawed wood, which is reduced by the insect to a kind of paste, and then is formed into a nest of a variable number of hexagonal cells, the number depending on the number of insects forming the community. The cells are arranged in a single tier; and after numerous cells are constructed, the nest itself partakes also of a hexagonal shape. As the tier is not enveloped in an outer case as is usual with other wasps, the openings of the cells are entirely unprotected, and are thereby exposed to the atmosphere. It is in these open cells that the insect resides during the first two periods of its existence; but it is during the larva state that the minute germs of fungi may get conveyed to the insect with its food[3], which consists of vegetable matter, as the insects have been found with an incipient vegetation previous to leaving the cells. These nests often become saturated and detached by the heavy tropical rains, as they are only united sideways to the small branch of a tree by a slender pedicle, and thus fall on the decayed vegetables that clothe the ground of the primeval forests of tropical countries, which may assist the growth of the parasite.

Of the *Polistes ? mexicana*[4] from Trinidad, Dr. Maddiana relates that it was "in an apparently perfect condition, glued somehow, by one wing only, to a leaf of a tree. From all parts of its body issued filaments from one to three inches long. They were wholly different from the Sphæria, being black, shining, and resembling the plant called Spanish Beard, or *Tillandsia usneoides*." Dr. Maddiana supposes "that in some instances the vegetation commences only after life has ceased," while Dr. Mitchell considers it "as likely that the seeds of the vegetable were planted on the larva or pupa. It is not necessary to suppose that death should have preceded their insertion."

The *Polistes rubiginosus*[5] from St. Vincent is represented in Pl. IV. f. 4, having a fungus like that on *P. americana*.

A specimen of this genus is represented in Pl. V. f. 6, which is contained in Mr. Westwood's collection, having two fungi about two inches long proceeding from the under part of the thorax, one of which has an ovate head at the apex, of a pale green colour. The insect is imperfect, and has become black, probably from the effect of the fungus. The figure of another imperfect specimen of this genus is given in Pl. IV. f. 5, having short branched fungi at the base of the wings. Both these examples are too imperfect to apply any specific names to them; but they were no doubt brought from tropical America.

The *Icaria cincta*[6], figured in Pl. IV. f. 3, from Western Africa, is also in the imago state; and it is the first African insect that has been observed to form the basis of a parasitical plant. It is most remarkable for bearing, apparently, two kinds of fungi. One, which is represented by two examples only, proceeds singly from the base of each wing; they are short, rather thick, with a prominent club-formed termination. The other kind consists of four rather long and very slender filaments, arising from the third joint of the abdomen; each filament has a slight indication of a club-like termination, apparently trifoliated: they are altogether different from those at the base of the wings, yet they may be the same fungus under a different manner of growth. The insect has retained its proper colour, and is affixed, like the former, longitudinally to the branch by means of its tarsi and the apex of its abdomen.

The family *Apidæ* may here be referred to, as the larvæ of British Bees, covered with a fungoid parasite, have been discovered by Mr. F. Smith while digging into their nests, which they form either in wooden posts or in banks of earth. They have, however, been more particularly found so affected in the colonies of *Anthophora acervorum*[7]. This latter insect forms in chalk-pits a nest of such amazing extent, that in the middle of April a dark flickering shadow is cast on the ground from the countless insects assembled.

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[1] Mitchell, *Sillim. Amer. Journ.* xii. p. 22, 1827. See also Maddiana, *Journ. de Pharm.* 1829, p. 158 (Guadaloupe); Westw. *Introd. Classif. of Ins.* ii. p. 251 (Vespa vegetans); Hearne, *Journ. Proc. of Ent. Soc.* i. p. lxvi; Ch. Rob. *Végét. Paras.* p. 663.

[2] *Penny Cyclop.* 'Dry-rot.'

[3] Mr. Mitchell thinks "that under particular circumstances the body of the insect, while yet alive, becomes the soil or base upon which vegetables fasten themselves, and from which they derive support."—*Sillim. Amer. Journ.* xii. p. 23.

[4] Vespa mexicana, *Mitchell*, Sillim. Amer. Journ. xii. p. 24 (1827).

[5] Smith, *List. of Hymenopt. Ins. B. M.* v. p. 111.

[6] Lepel., *Sauss. Guêp. Soc.* p. 39. t. v. f. 9; Smith, *List of Hymenopt. Ins. B. M.* v. p. 97.

[7] Smith, *List of Hymenopt. Ins. B. M.* ii. p. 321; id. *Brit. Hymen.* i. p. 204.

See Xylaria apum, *Gray*, Nat. Arrang. Brit. Plants, i. p. 511, as found on the pupæ of Bees. It has lately been supposed that many Hive Bees are annually destroyed by some kind of fungoid parasites.

It was thought by Dr. Leidy[1] that the insects of the Order HETEROPTERA, which "suck the juices only of plants or animals, through a delicate proboscis," were "placed under circumstances the most favourable of all animals to avoid taking in, with their food, spores and plants of a parasitic character." It seems, however, that, like Homoptera, which are equally suctorial, they are liable to become the base of fungoid parasites. Thus, the *Pentatoma prasina*[2] forms the base of the curious filamentous fungus, Penicillium Fieberi[3], which covers the antennæ, the four front legs, the sides of the thorax and outer basal portion of the elytra, although, when discovered, the insect was dead. And the *Metapodius latipes*[4] has been recorded as having, from the dorsal portion of its abdomen, a series of lengthened fungoid filaments.

The next Order, HOMOPTERA, embraces various species of *Cicadæ* that are liable to become the bases of fungoid parasites, several of which are represented in Pl. IV. f. 9–14, and in Pl. V. f. 1–3.

These insects reside, during the first two periods of their existence, in the earth, into which they descend immediately after being released from the eggs (which had previously been deposited by the female in slits in dead branches by means of an ovipositor), seeking the roots of trees, ferns, and other plants, to which they cling, and extracting the sap by the insertion of their proboscis into the bark, thus causing even large trees and plants to wither and die from the countless number of their assailants. They continue to reside in the earth even after they have undergone their metamorphosis into the pupa state, in which condition they are equally active and destructive to the roots of trees, &c.; indeed the only difference between these two states is, that the pupa possesses rudimental wings, visible on the sides of the body. They usually remain near the surface; but as winter approaches they descend into the earth to the depth of 2 or 3 feet, which they are enabled to do by means of the great strength of the anterior legs of the larvæ and pupæ, which can even penetrate through the most solid and hard-trodden road: but the digging-apparatus is transformed into legs resembling the other four, on the insect assuming the last or perfect stage of life. It is during the first two stages that these insects, especially in rainy seasons, become the bases of the parasite, which first commences in the interior of the insect: after a time the thallus bursts forth at that part of the outer case from which the insect would escape at the period of assuming the different states of pupa and imago; that is to say, at the longitudinal suture on the middle of the upper surface of the head, and on the dorsal portion of the prothorax and mesothorax. It is from this thallus that the fungoid parasite takes its rise, either from the head (Pl. IV. f. 11) or from the prothorax (Pl. IV. 12), and even from the mesothorax (Pl. IV. f. 14); but this may depend upon the position of the insect at the commencement of the outer development of the fungus. In some specimens, however, the fungus springs from the joints of the upper and under surface of the abdomen, and sometimes also from the joints of the two fore-legs (Pl. V. f. 3). The examples all show that the insect was only imbedded just below the surface of the earth, or in vegetable matter, during the period of the growth of the fungus.

The parasite which adopts the *Cicadæ* of the West Indies[5] as the basis of its development, assumes various forms of growth:—viz. a lengthened stem, with proliferous processes in or near the middle, and a subglobose head at its apex (Pl. IV. f. 11[6]) (Jamaica);—a short stem with proliferous processes, but without terminal head[7];—several stems proceeding from one base (Pl. IV. f. 13) (Jamaica), terminating in subglobose heads[8];—a lengthened and smooth stem, ending in a clavate head (Pl. IV. f. 12[9]) (Jamaica);—a lengthened and smooth stem with short tuberculated heads[10];—a smooth stem with irregular-formed heads[11];—a lengthened and smooth stem with a very long granulated head (Pl. IV. f. 14[12]);—proliferous processes, proceeding at once from the head or thorax (Pl. V. f. 1, 3), and the fungus also appearing from the joints, either on the upper or under surface of the abdomen (Pl. V. f. 2, 3), and sometimes from the fore-legs (Pl. V. f. 3) (Jamaica (?), Westw.);—a short stem, which divides into two branches, each rather longer than the main branch (Pl. V. f. 2) (Jamaica (?), Westw.).

"The *Cicada septendecim*[13] is also subject," says Dr. Leidy[14], "to a fungous disease. The posterior part of the abdomen has been observed in several instances to be filled with a mass of oval spore-like bodies, embossed upon the surface, but becoming smooth from endosmosis when placed in water."

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[1] *Proc. Acad. Nat. Sci. Philad.* 1851, p. 210.

[2] Hahn, *Wanz. Ins.* ii. 6. t. 49, f. 149.

[3] Corda, *Pracht-flora*, t. ix.; Ch. Rob. *Végét. Paras.* p. 664.

[4] Acanthocephalus, *Westw.* Journ. Proc. Ent. Soc. iii. p. iv. pl. vi. f. 7.
Ercanthocephala, *Ch. Rob.* Végét. Paras. p. 664.
Metapodius latipes, *Dall.* List of Hemipt. Ins. B. M. p. 427.

[5] Jamaica. Cicada albiflos, p. 148, and C. mesochlora, p. 129, of *Walk.* List of Homopt. B. M.
Cuba. C. chariclo, *Walk. l. c.* p. 146.
St. Thomas. C. tomentosa, *Walk. l. c.* Suppl. p. 22.

[6] Vegetating Wasp, *Watson*, Phil. Trans. (1763) iii. p. 272. pl. 23. (Martinique and Dominica), Edw. *Birds*, pl. 335.
Clavaria sobolifera, *Hill*, *l. c.* p. 273; Buchner, *Nova Acta Cur.* iii. p. 441. t. 7. f. 12 (Cuba) (1767).
Musca vegetans, *Müll.* Nova Acta Cur. (1769), iv. p. . t. 7. f. 6; *id.* Journ. de Phys. (1771) i. p. 151. t. ii. f. 6.
Musca vegetabilis, *Ch. Rob.* Végét. Paras. p. 666.
Sphæria on Cicadæ, *Kirby and Spence*, Introd. to Entom. iv. p. 208.
Sphæria sobolifera, *Berkel.* Lond. Journ. of Bot. ii. p. 207.

[7] Fougeroux de Bondaroy, *Mém. de l'Acad. Roy. des Sci.* 1769, t. 4. f. 4.

[8] Spallanzani, *Nouv. Recher. sur disc. Microsc.* 1769, t. 6. f. 1, 3 (Caraibes).

[9] Holm, *Acta Hafn.* 1781, t. . f. xi. xii. (St. Thomas).

[10] Fougeroux, *Mém. de l'Acad. Roy. des Sci.* 1769, t. 4. f. 5, 6.

[11] Fougeroux, *l. c.* t. 4. f. 7, 8.

[12] Fougeroux, *l. c.* t. 4. f. 7.

[13] Walk. *List of Homopt. B. M.* p. 145.

[14] *Proc. Acad. of Nat. Sci. Philad.* 1851, p. 235.

The specific name indicates that the remarkable period of seventeen years recurs with perfect regularity, before each generation, numbering many millions of individuals, attains sufficient maturity to change into the imago or perfect state. Their appearance varies in different districts, though this lengthened interval always passes before each series appears, and must occasion the insect to undergo many changes of temperature and weather. The same reason probably causes it to be liable to become the basis of the fungoid parasite. It dwells chiefly in localities abounding in trees, and even on land which was free of them before, when trees, especially those bearing fruits, have been planted upon it; although it remains in some localities even after the trees have been removed, and then feeds on the roots of grasses, &c., still making its appearance regularly after the allotted period of seventeen years is passed. Their metamorphosis usually takes place in the night; but their reappearance is anticipated by the inhabitants of some localities, who register the year when they may be expected, so that they appear without creating much surprise.

The *Cicadæ*[1] of New Zealand also form the bases of fungoid parasites[2], which chiefly grow from the head and thorax in a series of short stems, that are sometimes matted together, each ending in several tuberculated proliferous processes (Pl. IV. f. 9, 10); sometimes the fungus also springs from the joints of the fore-legs.

As the insects thus infested are always in their larva and pupa states, it becomes impossible correctly to affix to them their proper specific names; but as the habits of all the species are similar in every respect, it is most likely that all those species which usually inhabit localities where the germs of these fungoid parasites exist, are equally liable to become the bases of them.

It is recorded that some species of *Cicadæ* are also liable to the attacks of a kind of *Isaria*, which owes its specific name to that circumstance[3].

The *Delphax saccharivora*[4] of St. Vincent is sometimes found (Pl. IV. f. 15) adhering to the midrib of the under surface of a leaf by means of a fungoid matter, in the same manner as flies, and from its body also spring lengthened filaments having a subovate head at their apex.

It is on the young and tender shoots of the sugar-cane that these insects are usually seen in immense quantities sitting on the midrib or large sap-vessels of the leaf, probing them with their proboscis to obtain the saccharine juice on which they regale themselves, and thus often causing from their number the death of the plant, to the serious loss of the growers. It is apparently while thus engaged that the parasite shows itself on the perfect insect.

* * *

In the last Order, Diptera, various insects have been noticed as affected by a peculiar kind of fungoid mould, viz.,

Dexia canina[5],
Musca domestica[6],
Musca vomitoria[7],
Anthomyia pluvialis[8],
Scatophaga stercoraria[9].

All these insects may occasionally be seen after autumnal rains, dead, on the bark of trees, on portions of various plants, on the windows and ceilings of houses, &c., adhering by means of a whitish fungoid matter or mould[10], which seems to have emerged from between the last segments of the abdomen beneath and the joints of the legs. The body and wings also become entirely covered by the same parasite, which under a highly magnifying power "appears to consist of elongated filaments in close contact." "When separated from the mass, some are found simple, and others terminated by a minute globule; those upon the wings appear merely globules[11]."

These flies, which are in the perfect state, become, while in activity, suddenly overtaken by the effect of the parasite internally, which causes the insect to settle on any object that may be in its way; death soon after ensues; and the rapid growth of the parasite having first affixed them by the abdomen and legs to the object on which they had rested, it then developes itself entirely on the outer surface of the insect, and even spreads itself for some distance around it, as may easily be noticed in those seen on windows, &c.

Some specimens of the genus *Tachina* have been found clothed by the *Isaria arachnophila* during the spring and autumn months[12].

A minute pupa of a Dipterous insect, which was found buried in moss, is represented in Pl. IV. f. 16[13], having a long slender smooth stem that rises from the middle of one side, with a globose head at its apex. While f. 17 of the same plate[1] is supposed to represent the pupa of another kind of Dipterous insect (*Tabanus*?), having a long fungus which springs from one end of it; it gradually enlarges to the apex, where it is somewhat truncated.

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[1] Ten small species have been recorded as found in New Zealand, viz. *Cicada muta*, p. 171, and *C. cingulata*, p. 114, Oliv., *C. sericea*, p. 169, *C. rosea*, p. 220, *C. cincta*, p. 204, *C. nervosa*, p. 213, *C. Arche*, p. 195, *C. indivulsa*, Suppl. p. 33, *C. bilinea*, p. 34, and *C. ochrina*, p. 34, of Walk. *List of Homoptera B. M.*

[2] Locust, or Sphæria Basili, *Taylor*, New Zealand, p. 424. fig. p. 421. Cordyceps Sinclairi, *Berkel.* Hook. Flor. N. Zealand, ii. p. 338.

[3] Isaria cicadæ, *Miquel*, Bull. des Sci. Phys. en Neerl. 1838, p. 83; Ch. Rob. *Végét. Paras.* p. 665.

[4] Walk. *List of Homopt. B. M.* ii. p. 353.

[5] Ch. Rob. *Végét. Paras.* p. 439; Walk. *List of Dipt. B. M.* iii. p. 843.

[6] Loudon, *Mag.* vii. p. 531; Walk. *List of Dipt. B. M.* iii. p. 900.

[7] Loudon, *Mag. N. H.* vii. p. 53; *Ann. Sci. Nat.* n. s. v. p. 316; Walk. *List of Dipt. B. M.* iii. p. 892.

[8] Walk. *List of Dipt. B. M.* iii. p. 921.

[9] Fennell, *Loud. Mag. of N. H.* vii. p. 61; Shuckard, *Journ. Proc. Ent. Soc.* ii. p. lxix; Walk. *List of Dipt. B. M.* iii. p. 979.

[10] Sporendonema muscæ, *Fries*, Syst. Myc. (1835).

[11] Westw. *Journ. Proc. Ent. Soc.* ii. p. lxiii. pl. xx. f. 2 (1837).

[12] Ch. Rob. *Végét. Paras.* p. 608.

[13] Kentrosporium microcephalum, *Wallr.* Beitr. zur Bot. ii. t. iii. f. 10.

The Arachnida are equally liable to be affected by several kinds of *Isaria*; thus, the *Mygale Cubana*[2] has been discovered with the body and legs covered by a yellowish-white parasite that has been named *Isaria gigantea*[3]. A species of *Aranea* from S. Carolina sometimes becomes the basis of the *Isaria phalangiophila*[4]; while another species, found in Europe, is occasionally seen during the autumnal months, attacked by the *Isaria tartarea*[5]; and a species of *Ctinus* is represented in Pl. IV. f. 18 as attached to a piece of rotten wood by means of a white kind of fungoid matter called *Isaria arachnophila*[6], which had emerged from the interior of the body, and had after death covered the upper part of the back, and then extended itself into several upright stems, enlarging towards their apex; it is from these that the minute germs of the future plants are shot forth when matured. The eggs of spiders[7], which are usually found in number together, carefully preserved in bags formed of web, also form the bases of *Clavaria militaris*.

The histories of the different kinds of insects that are liable to become the bases of fungi have thus been collected together; they have been drawn up from the various accounts published, from information kindly supplied, and from the recorded habits of the infested insects themselves, or of those which are most nearly allied to them, such alliance being inferred from the characters presented by the insect, in whatever stage of life it may have been found. It is now the writer's intention to glean from these various sources certain facts, with the view of endeavouring to unravel, in part at least, the mode in which the mysterious process of combination takes place between the insect and the plant, as well as the subsequent development of the latter. These facts have been embodied in regular form, in order to point out what to look for, should any, either of the known Entomophytes, or of any new species, fall in the way of those who may take an interest in the subject, and may thus be induced to add to our knowledge of these highly curious plant-insects.

It is necessary first to observe, that life is certainly not extinct[8] when the insect first becomes the basis of these vegetable parasites, as has been indicated since the time of Father Torrubia in 1754 (in his case, it must be admitted, under rather marvellous circumstances), although this is now a very generally received opinion. It may be further noticed, that most of the insects thus affected are solely vegetable feeders, although there are a few which feed on animal matter. It is also supposed that the spores or seeds of the parasites may become connected with the insect in two ways; either by the insects swallowing the seed with their vegetable food[9], or by its settling on some portion of the exterior surface, and thus finding its way into the interior. That the seed is taken in the former mode is most probable[10]: it is so infinitely minute[11], that it can only be seen by the most powerful lenses, and therefore so light as to be wafted through the air by the slightest motion of the wind. When thus floating about, it may either settle on the vegetation or fall on the ground, where it would become mixed with the soil or vegetable matter in which most of the insects in their earlier stages of life seek for nourishment, and by these means the seeds may be taken in with the food, which is thought to be "the most frequent way" by which the fungus becomes connected with "aërial animals[12]." The idea that the seed finds[13] or bores its way into the interior, after it becomes attached to the external surface, is

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[1] Kentrosporium clavatum, *Wallr. l. c.* t. iii. f. 22.
Clavaria granulosa, *Bull.* Hist. 199. t. 496. f. 1.
Sphæria militaris, *Bolt.* Fungi, t. 128 (?).

[2] Walck. *Ramon de la Sagra, Voy. Cuba, Crypt.* p. 610.

[3] Montagne, *Ramon de la Sagra, Voy. Cuba, Crypt.* p. 309; Ch. Rob. *Végét. Paras.* p. 610.

[4] Link, *Spec.* ii. p. 114.
Isaria aranearum, *Schweinitz*, Carol. no. 1209. Syst. iii. p. 278; Ch. Rob. *Végét. Paras.* p. 609.

[5] Wallr. *Beitr. zur Bot.* ii. p. 147. t. 111.
Isaria tartarica, *Ch. Rob.* Végét. Paras. pp. 608, 669.
Isaria sphærophila, *Wallr.* Beitr. zur Bot. p. 160.

[6] Dittmar, *in Sturm, Germ. Fl.* t. 55; Ch. Rob. *Véget. Paras.* p. 607.

[7] Berkel. *Engl. Flor.* v. ii. p. 232.

[8] This is also the case with living vegetables, which acquire a certain condition through the effect of extreme moisture, in consequence of which they form the basis of vegetable parasites or fungi; and in the same manner, living insects, while in health, become the bases of insect parasites, and even remain, for some time after they are attacked, in a living state, but gradually die as the parasites advance to maturity.

"The chief or leading fact intended herein to be established, is the derivation of nourishment by the vegetable from the *living* animal."—Mitchell, *Sillim. Amer. Journ.* xii. p. 27.

[9] Dr. Leidy thinks that "those insects which eat large quantities of vegetable solid food, especially such as eat decaying substances, are very much infested with parasites."—*Proc. Acad. Nat. Sci. Philad.* 1851, p. 210.

[10] Holm considered, as far back as 1781, that the seeds were eaten with the food by the larva, and that they remained for some time in the intestine (*Coryph.* p. 64). It has since been observed by M. de Quatrefages, that various medicines can be given to silkworms by sprinkling the leaves of the mulberry-trees on which they feed; which shows that the spores or seeds may also be taken by the same means.

[11] Sporules, or seeds of fungi, are so minute, that M. Fries estimated above ten millions in a single plant of the *Reticularia maxima*: they were so subtile, that they were like smoke. Still more wonderful does it appear, that a seed, minute enough to be wafted invisibly by a breath of air, should be the theatre of all the chemical changes that produce its germination.

[12] Leidy, *Proc. Acad. Nat. Sci. Philad.* 1851, p. 210.

[13] Mitchell, *Sillim. Amer. Journ.* xii. p. 23.

Sir W. Hooker believes, in reference to the New Zealand Entomophytes, that the caterpillar is "in the act of working the soil" when "the spores of the fungus are lodged in the first joint of the neck" (*Lond. Journ. of Bot.* ii. p. 209); while Professor Owen and Dr. Thompson think "that the parasite fell upon and became connected with the one which cannot be entertained with regard to Entomophytes, when it is taken into consideration that not the slightest sign of any such operation on the outer surface of the insect can be observed, though various kinds of insects have been obtained completely filled internally with the thallus, and without any external appearance of the parasite; nor can it be so with caterpillars which have changed their skin on assuming the chrysalis state, after burying themselves in moss, &c., and which are found in the latter state to form the bases of fungi.

It is now allowed by most writers that the germination of the seed commences in the interior of the insect; and it is also evident that it does not depend altogether on "being nourished by the warmth and moisture of the interior of the insect [1]," but rather on the insect becoming sickly[2] and feeble by the effect of the heavy rains that fall at stated periods in the intertropical regions[3]; or from the extremely humid seasons which prevail occasionally during certain months of the year in most extratropical countries[4]. This is especially applicable to those insects that reside in the earth, or in decayed vegetable matter, or in an exposed nest, as they must at such times be saturated by the water, and thus become completely enfeebled by its influence, after which the seed rapidly germinates, and then the thallus eventually expands itself throughout the interior of the insect, and thus the plant gradually predominates over the vital principle of the animal[5]. The same thing is supposed to occur, although under other circumstances, with the silkworms, and is thought to be occasioned by the leaves on which they are fed being saturated during humid seasons with a greater degree of moisture[6], and by the external dampness penetrating into the apartments in which the insects are confined, thereby affecting the atmosphere with a degree of closeness[7] and humid warmth that is injurious to the insects and causes them to become sickly and feeble, and thus to fall easy victims to the fungoid parasite or mould.

The thallus gradually developes itself, and fills the outer case of the insect to such an extent, that it has been remarked that "it seems entirely metamorphosed into a vegetable, with the exception of the skin and intestines[8]"—even occupying "the orbits of the eyes, and to the points of the tarsi[9]." The insect retains its natural form, although its internal parts are dried up by the growth of the fungus. The outer portion of the plant then forces its way through the skin or tissue at various places, through the joints of the body, and even in some cases through the hard surface of the head, thus exhibiting very great power of development, while progressing towards maturity; it also shows various peculiarities in the manner of its growth and form, which may in some cases be occasioned by the habit and position of the insect at the time it feels the effect of the inner plant or thallus.

It may be here mentioned that M. Tulasne[10] considers that some of the Entomogenous fungi are represented under two different forms during their growth; for instance, he believes the *Isaria crassa*, Pers., is strictly united with the more complicated form of *Sphæria militaris*. He also says that it would be interesting to ascertain what *Isariæ* correspond with the three European species, as *Sphæria entomorhiza*[11], *Sph. gracilis*, and *Sph. myrmecophila*. It is not impossible but that the more complete state of the fungi may be reserved for other climates; thus, *Isaria sphecophila* may belong to some tropical species which is mentioned under the name of "*Guêpes végétantes*[12]:" nor would he be surprised if the *Botrytis bassiana* should eventually prove to be the same species as *Sphæria sinensis*[13], or some analogous

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caterpillar previous to its being buried in the earth—causing it to sicken and die, and then commenced the progress of germination."—*Med. Times*, 1843, p. 65.

It is even thought by some authors to take place while the insect is in a state of hybernation.

[1] *Tasm. Journ.* 1842, p. 307.

It is believed by Dr. Thompson that the nourishment is derived from the adipose tissue of the body of the insect, and not in any degree from the surrounding earth.—*Med. Times*, 1843, p. 65.

[2] "Isariæ or moulds are developed as a product of a sickly state of the animal."—*Ann. & Mag. of N. H.* 1841, p. 406.

[3] The falls of rains which have been recorded within the tropics, and which usually happen in mid-day, amount, in Haiti, to 127·88 inches; in Guadaloupe, to 292·03 inches; in Jamaica, to 70·00 inches annually. In the northern parts of South America the depth of rain has been stated to be 229·20 inches annually, while in some parts of Brazil it has been said to have reached 280·00 inches in the year; but the mean quantity is noted at 115 inches for the year.

[4] Some portions even of extratropical countries are subject to immense falls of rains, *ex. gr.* in the Himalaya Mountains, where no less than 264 inches are said to have fallen in one month: in the interior of China, it is recorded only at 68·3 inches during the year, and the rainy season occurs from April to October; while on the east coast of China it happens from October to April. The mean quantity of rain that falls in the Old World is about 76 inches in the year. In countries where the larger examples of Entomophytes are found, as in the south-eastern corner of Australia, Tasmania, and New Zealand, the rains usually fall during the autumn and winter months, and are said to descend as it were in one immense sheet of water, and thus suddenly saturate the earth, to the detriment, in some cases, of animal and vegetable life.

[5] "These facts, combined with others, tend to show that, to a slight degree, there is an independent existence in the different parts of the same insect, where life is retained for a considerable time in parts, although they may be separated."—Waterh. *Proc. Z. S.* 1839, p. 146.

[6] M. de Quatrefages has since remarked, that silkworms fed on moistened leaves speedily felt the effects of them, and that very few of them spun cocoons.

[7] M. Audouin thought, "that when live insects are attacked by fungi, it is only when they are confined in damp, unventilated places."—*Compt. Rend.* 1837. M. de Quatrefages has lately proposed that silkworms should be reared in open sheds, which has been found to preserve them from the attacks of the spotted disease.

[8] *Lond. Journ. of Bot.* ii. p. 209.

[9] *Penny Cyclop.* 'Dry-rot.'

[10] *Ann. des Sci. Nat.* 1857, p. 42.

[11] This species is recorded in these pages, following the opinions of the various authors, to be the same fungus as is seen on some *Curculionidæ*, on larvæ of *Ancylonycha*, and on the *Polistes americana*: thus, it is considered by them to inhabit other climates than Europe, and also to partake of various forms.

[12] Dr. Halsey considers this fungus to be the same as *S. entomorhiza*, while the Rev. Mr. Berkeley has thought it to be the same as *S. militaris*.

[13] This also was originally considered as the *S. entomorhiza* by some authors.

species of *Sphæria*[1]. It may be further added, that a difference of habits may be the means of producing a change in some cases: thus, the *Sporendonema muscæ*, which is parasitic on common flies during autumn, is stated to grow out into *Achlya prolifera*, if placed in water[2].

Many caterpillars, it should be noticed, are found in the same locality, apparently unaffected by the parasite, which may be caused by the insect not falling in the way of the seed while feeding, or by its health not having been so greatly enfeebled by the humidity as that of others around it, to allow of the germination of the seed.

When chrysalids form the bases of the parasite, it is supposed that the caterpillar had obtained the germ with its food previous to the change into the inactive state. It is still thought that extreme dampness is necessary for the development of the parasite, which the chrysalis is very liable to suffer from, as it either lies in the earth, vegetable matter, or moss, mostly without any kind of covering, or with only a slight cocoon, for some time before the period arrives to undergo its final transformation into the imago or perfect state. The development in this case is in every respect similar to what it would be in and on the caterpillar; but it is more rarely met with.

The spores or seeds, it may be remarked, are probably equally taken during dry seasons along with the food by the new series of insects that make their appearance in fungoid localities; but owing to the atmosphere being free from humidity, the insects are able to retain their health and energy, and are thereby rendered capable of throwing off quickly the remains of their food, as is the case with all vegetable feeders; sufficient time is consequently not allowed for the germination of the seed, and thus the insects escape and undergo all their metamorphoses, and ultimately reach the perfect state, in which the insect after a short time leaves a new progeny, some of which may or may not form the bases of their fungoid enemies at a period unfavourable to the insect, but more conducive to the development of the fungus.

In connexion with the statement that the development and growth of the internal thallus are favoured by extreme moisture, an experiment may be referred to which was made by Dr. Leidy[3], who placed some fragments of fungoid matter, taken from the interior of a mole-cricket, which did not appear externally, in a small glass-case along with some moist Sphagnum; these fragments after a time developed a series of cream-coloured stipites from three lines to an inch in length, varying in number on each fragment. It is probable that these productions would eventually have formed the outer development of the plant, had not the mole-cricket been discovered and removed from its peculiar locality[4].

The absorbent nature of the fungus may occasion in a great measure the preservation of many of the specimens of Coleoptera in the larva and imago states, of caterpillars and chrysalids of Lepidoptera, and of the imago of Hymenoptera, &c., which are in some cases so clean and fresh as to give us further reason to suppose that life was not extinct when the parasite commenced its growth, and that its development was very rapid, and thus allowed no time for even the soft larvæ or caterpillars to become decayed[5] and injured, provided an early discovery of the specimen took place, as it would also counteract the destructive influence of the moist places in which they are usually affected.

It is well known that the Fungus tribe are remarkable for the suddenness of their appearance: this has occasioned some authors to suppose that some kinds of the parasites are in the first instance spontaneously developed while the animal is in a sickly state, or by certain organic changes in the fat (when it has ceased to be under the influence of vitality), as in the silkworm for example, so as to render its component parts capable of spontaneously producing mould; and that when once formed, it is capable of being extended to others by spores or seeds[6].

On the other hand, these opinions are thought to be untenable, as the plants are more probably propagated by seeds on their first development. Their germination is developed under particular, and sometimes sudden circumstances, principally during the humidity of the spring and autumnal portions of the year. The rapidity of the growth in some of the filamentous fungi in particular is so great, that it may be watched and observed both in *Isaria* and *Botrytis*, especially in the latter, as it increases and spreads itself over the external surfaces both of vegetable and animal substances, while progressing towards maturity.

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[1] Thus, circumstances not only combine to alter the appearance of fungoid plants during their growth, but such alterations also take place with some of the parasitic animals, as Entozoa. It has been proved that the early stages of these animals have been swallowed or eaten with their victims by certain larger kinds of birds, quadrupeds, and fish, as these mysterious parasites are found on and in various parts of certain kinds of small animals; and though the victims have been digested, yet the parasite has remained in the intestines uninjured and nourished, and it has in time become transformed into a more perfect form, and thereby appeared as a totally different parasite from that of the first state, many of which have been described and named as distinct genera of animals from those in their earlier growth.

[2] *Ann. & Mag. of N. H.* 1841, p. 406. This is certainly a remarkable fact, when it is considered that the first-named is regarded as a filamentous fungus, and the second as belonging to the Algæ.

[3] *Proc. Acad. Nat. Sci. Philad.* 1851, p. 210.

[4] A further illustration of this fact is given by the same author in a curious account of a portion of *Passalus cornutus* which had lain half immersed in water for two days, upon and around which no less than four kinds of vegetable parasites, consisting of filamentous fungi and algæ, were produced; while on some Ascarides, which had been in water for a few days, he was able to observe in a single morning all the stages of development of *Achlya prolifera*. These plants he considered sprung from pre-existing germs, derived from a parent, which had remained inert until circumstances favoured their germination.—*Proc. Acad. Nat. Sci. Philad.* 1850, p. 7.

[5] "These mixed associations of vegetable with animal substance are not prone to rapid putrefaction, but remain entire long enough to be collected by naturalists and become objects of scientific inquiry."—Mitchel, *Sillim. Amer. Journ.* xii. p. 27.

[6] *Ann. & Mag. of N. H.* 1841, p. 405.

It has been thought, that the exposed position assumed by the diurnal Lepidoptera in their three stages of life preserves them from becoming the bases of fungoid parasites, as their chief time of existence is during the summer months, when the complete state of vegetation enables them to seek protection from the rains by resorting to the under sides of the leaves, trunks of trees, &c.; and even should they become wet, the moisture is soon removed by the surrounding air, or by basking in the sunshine; and thus they are kept sufficiently free from that extreme moisture which appears to be essential to produce that particular state of the insect which assists towards the development of the seed of the fungus, should it be taken in with the food.

It may further be stated, in order to show that the parasitical fungi vary according to the habits of the insects, that those which reside in the earth, or in decayed vegetable matter, or bury themselves in damp moss, &c., generally become the bases of true fungi of the genera *Sphæria*, *Cordyceps*, *Clavaria*, and *Ceratonema*; while those which remain during some, or the entire portion of their career exposed to the atmosphere, are usually affected by filamentous fungi of the genera *Isaria*, *Botrytis*, *Penicillium*, *Sporendonema*, and *Stilbium*. It may also be observed, that certain species of parasites never appear except on particular species of insects, and even this depends on the peculiar nature of the habits which they assume at different periods of their existence, when they become subject to a certain condition that is highly necessary for the development of the parasites[1]; but these periods vary in the different Orders: viz. in *Coleoptera* it is during the larva and imago states; in *Lepidoptera* (nocturnal) during the caterpillar, chrysalis, and imago; in *Hymenoptera* during the pupa? and imago; in *Orthoptera* during the imago; in *Heteroptera* during the imago; in *Homoptera* during the larva and pupa, and in one case only the imago; while in *Diptera* it takes place during the pupa? and imago states.

Other circumstances also cause the Entomophytes in some countries not to appear for long intervals, even to the extent of several years[2], though the insects which usually become their bases may have numerously appeared over and over again on the return of the usual allotted season of their existence.

The geographical distribution of the insects which are at present known to become the bases of parasitical fungi varies in the different Orders, and is best exhibited in the following Table:—

	Great Britain.	Europe.	Asia and Archipelago.	Africa.	Madagascar.	Australia.	Tasmania.	New Zealand.	North America.	South America.	West Indies.
Coleoptera	*	*	...	...	*	...	...	*	*	*	*
Lepidoptera (nocturnal)	*	*	*	...	...	*	*	*	*	*	*
Orthoptera	...	...	...	...	...	...	...	...	*	...	...
Hymenoptera	*	*	*	*	...	...	...	...	...	*	*
Heteroptera	...	*	...	...	...	...	...	...	...	*?	...
Homoptera	...	...	...	...	...	...	...	*	*	...	*
Diptera	*	*	...	...	...	...	...	...	...	...	...
Arachnida	*	...	...	...	...	...	...	...	*	...	*

From this table it may also be perceived that the Lepidoptera (nocturnal), Coleoptera, and Hymenoptera of different localities are more suited by their habits of life to form the bases of parasitical fungi than any of the other orders of insects.

The foregoing remarks entirely refer to those parasites that germinate in the interior of insects. It will be necessary also to allude to those which have fungoid parasites adhering only to the outer surface of the living insect, of which, however, there are but few instances as yet made known, and these are confined to species of the families *Brachinidæ*, *Gyrinidæ*, and *Staphylinidæ*, which either reside near to or in water. This circumstance leads one to suppose that aquatic or semi-aquatic habits are absolutely necessary for these insects to become the bases of the curious and extremely minute parasites which infest them[3]. These plants exhibit a very different formation, and thereby a total variation of habits, from all the other fungoid parasites. Water has in this case not only been the means by which the parasite became connected to any part of the outer surface of the insect, but it can scarcely be doubted to have afterwards assisted by its influence in the germination of the spores or seeds. It is generally thought to be one of the best means for the conveyance of the spores of some kinds of parasites (Algæ) into the interior of insects.

The results obtained from the foregoing histories of the various Entomophytes seem to show, that if the countries having humid primeval forests, or subjected to heavy rains, especially within the tropical portions of the world, were diligently searched by collectors, they would probably produce numerous examples of this curious phenomenon. But it would seem that they have little power to attract the eye of the botanist, who, while searching for, and being surrounded by, the more showy, and therefore more attractive objects of the vegetable kingdom, scarcely notices their slight appearances above the surface of the earth, and either entirely passes them over, or only obtains them under accidental circumstances; while the entomologist too often looks upon the insect which is the bearer of a parasite as disfigured, and thereby rendered useless for collections. These reasons may in some measure account for the apparent neglect manifested towards them until within the last few years.

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[1] It is said that Nutmegs and Mistletoe seeds require passing through the stomachs of birds before they germinate: may not therefore a similar process, under certain circumstances, be required by the spores or seeds of these peculiar fungi, by entering the interior of insects, and thus meeting with a certain chemical action which is necessary before they germinate?

[2] The drought, for example, that occurs in Australia after intervals of ten or twelve years, and which prevails sometimes for a period of two or more years, during which little or no rain falls, may constitute the intervals that are referred to as occurring between the times in which the fungoid parasites are found.

[3] M. Rouget thinks, from their being found both in dry and moist places on the mountains in the environs of Dijon, that the development of those on *Brachini* may be due to some atmospherical circumstance, or to some peculiarity of the locality.—*Ann. de la Soc. Ent. Fr.* 1850, p. 23.

It is hoped, in conclusion, that these pages may awaken some curiosity, if not interest, in favour of these singular productions, and thus lead to further inquiry as to the species of insects that unfortunately become the bases of the fungoid parasites. This inquiry, which was the chief object of the present pamphlet, would be greatly assisted if those who may happen to find any specimens of Entomophytes could, at the same time, secure some examples of the same insects in an unaffected state in any of their three stages of existence, but especially in the perfect or imago state, which are no doubt usually to be seen about the same locality, and thus at once determine the scientific name. If, too, a record were made of the circumstances under which the Entomophyte was placed at the time of its discovery, it might probably assist in unravelling the mystery in regard to the mode in which the original combination with the insect, and the germination of the seeds of these remarkable parasitic fungi, are brought about.

ADDENDA.

Page 12: to follow the account of the insect belonging to the family *Liparidæ*.

A species of the family of *Arctiidæ* has been recorded by Professor Lebert[1] as affected by a fungoid mould. He collected in the neighbourhood of Berlin, during the summer of 1826, a great many caterpillars of the *Arctia villica*, for the purpose of watching their growth. These insects on arriving at their full size became quite soft, and then suddenly died; soon after they became hard, and, if bent, would easily break into two pieces. Their bodies were covered with a beautiful shining white mould. If some of the caterpillars affected with the parasitic mould were placed on the same tree with those apparently free from its attack, the latter soon exhibited signs that they also were attacked in the same manner, in consequence of the two series only coming in contact with each other.

The caterpillars of this family are usually hatched in August, and they remain in the larva state throughout the winter, until the end of May or beginning of June, when they change into the pupa, after which they do not change to a moth until the commencement of July.

At the end of the second column of page 15, it is noticed, that Hive-bees are supposed to be destroyed by a kind of fungoid parasite; which the following account may further elucidate.

Mr. Timpron Martin, of Liverpool, records, that three hives were placed in a dry attic in October last; each hive was enveloped in a piece of calico, the four corners of which were brought together over it, and thus formed a loop, by which it was suspended from the ceiling. This mode of treatment is supposed to have given more air to the bees in the interior than they could have had through the summer, while the hive was placed on a stand. The hives were taken down about the 14th of March; the bees in two of them were found to be in a healthy state, but all the bees in the third hive were dead. In this last-mentioned hive there was abundance of honey when it was opened, and it was clear that its inmates did not die for want; but it was noticed that there was an appearance of mould on the combs. It was thought that the bees might probably have died during the early part of February; but they were certainly alive in the hive in January.

The Rev. H. Higgins supposed that the bees might probably have died from the growth of a fungus, and he obtained some of the bees for examination, which were transmitted in a dry state, and were found by means of a lens to have no indications of vegetable growth. On examining, however, a portion under a compound microscope, the head and thorax were clean; but a portion of the sternum had innumerable very minute, linear, slightly curved bodies, showing the well-known oscillatory or swarming motion. In the abdomen of several bees which showed no external appearance of the growth of any parasite, there was obtained an abundance of well-defined globular bodies, resembling the spores of a fungus. No trace of a mycelium was visible; the plants had come to maturity, fruited, and withered away, leaving only the spores. But it appears uncertain whether these spores were developed before or after the death of the bees[2].

Page 17.—A further account of the North American *Cicada* having been published, it is thought right that it should also be added. During the spring of 1851 some twelve or twenty specimens were found from amongst myriads of *Cicada septendecim*, "which, though living, had the posterior third of the abdominal contents converted into a dry, powdery, ochreous yellow, compact mass of sporuloid bodies." The outer coverings of that portion of the insect were "loose, and easily detached, leaving the fungoid matter in the form of a cone, affixed by its base to the unaffected part of the abdomen of the insect." The fungus may commence, says Dr. Leidy, its attacks upon the larva, develope its mycelium, and produce a sporular mass within the active chrysalis [pupa]: when in this stage many are probably destroyed; but should some be only affected so far as not to destroy the organs immediately essential to life, they might undergo their metamorphosis into the imago, in which case they would be affected in the manner previously described. The reason he assigns "of the fungoid production being always found in the last-mentioned situation, arises probably from the fact that the access of the sporules to the interior of the animal is much easier through the generative and anal apertures than through the more delicate passage of the proboscis[3]."

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[1] *Berl. Ent. Zeit.* 1858, p. 178.

[2] *Proc. Lit. & Phil. Soc. of Liverp.* 1857–58; *Proc. Linn. Soc.* 1858, p. 29; *Ann. & Mag. of N. H.* 1858, p. 387.

[3] *Smithsonian Contr. to Knowl.* v. p. 53.

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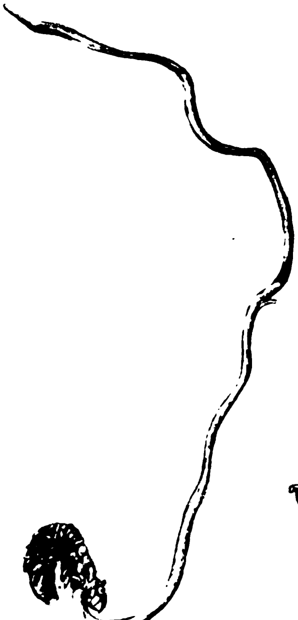
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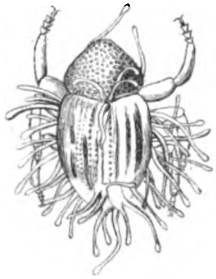
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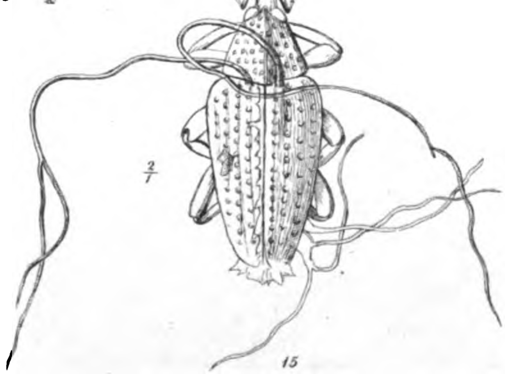

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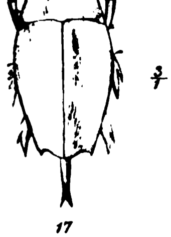

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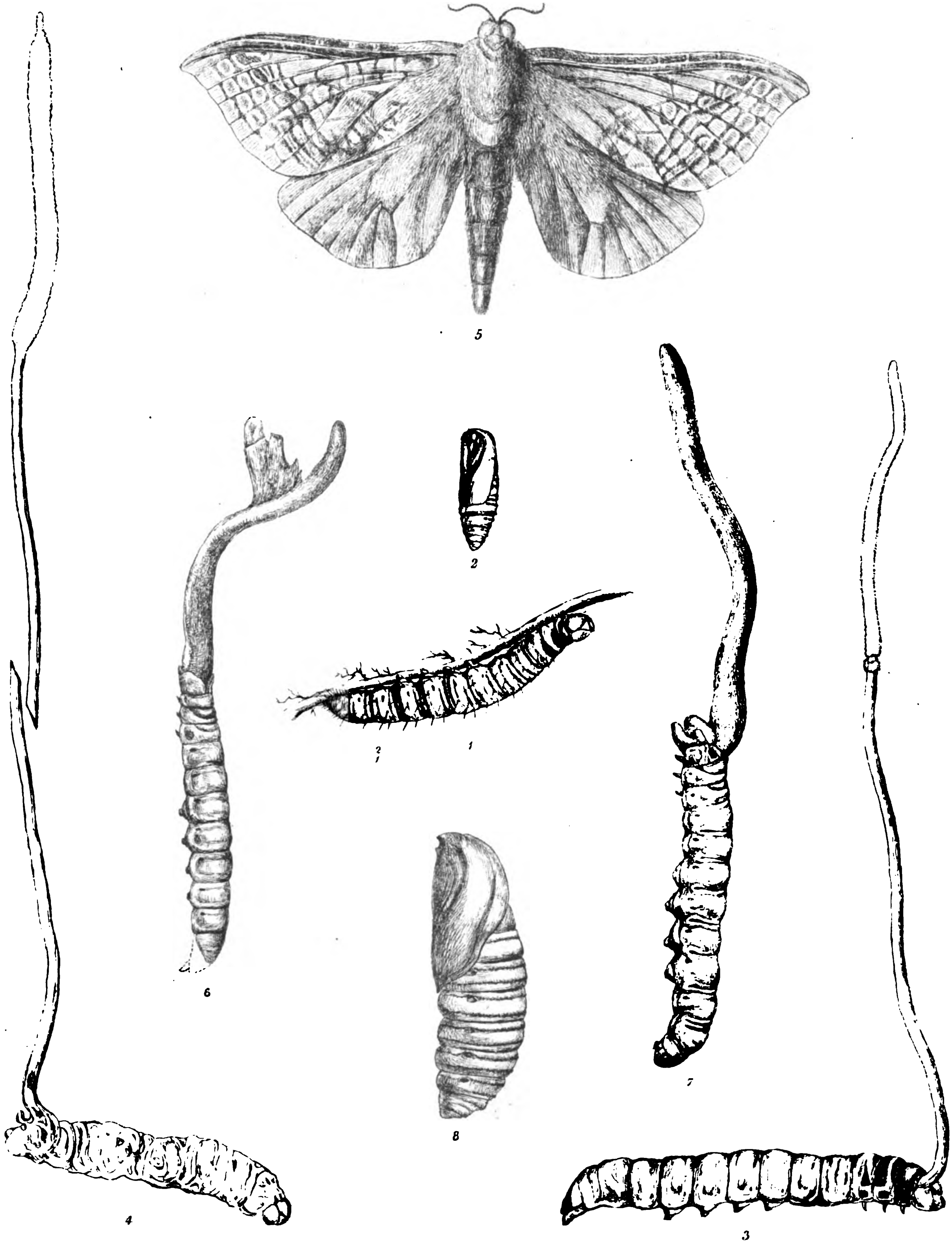

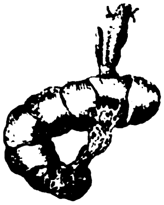
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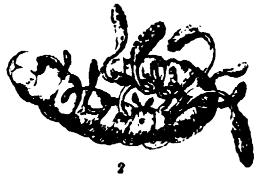
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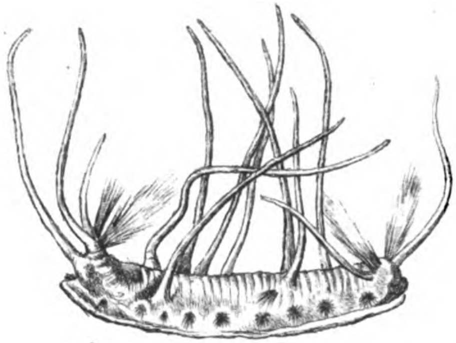
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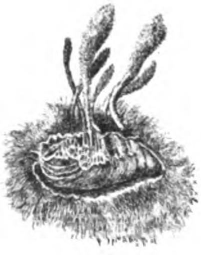
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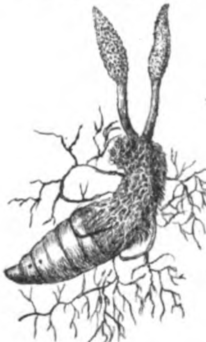
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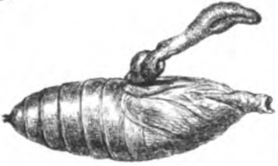
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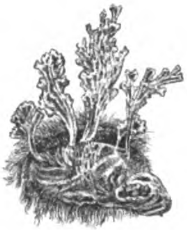
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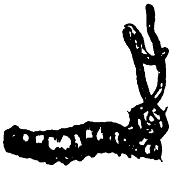
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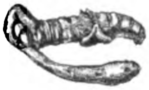
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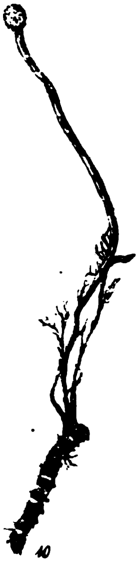
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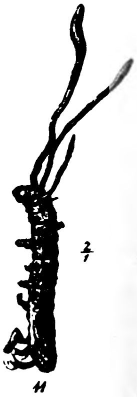

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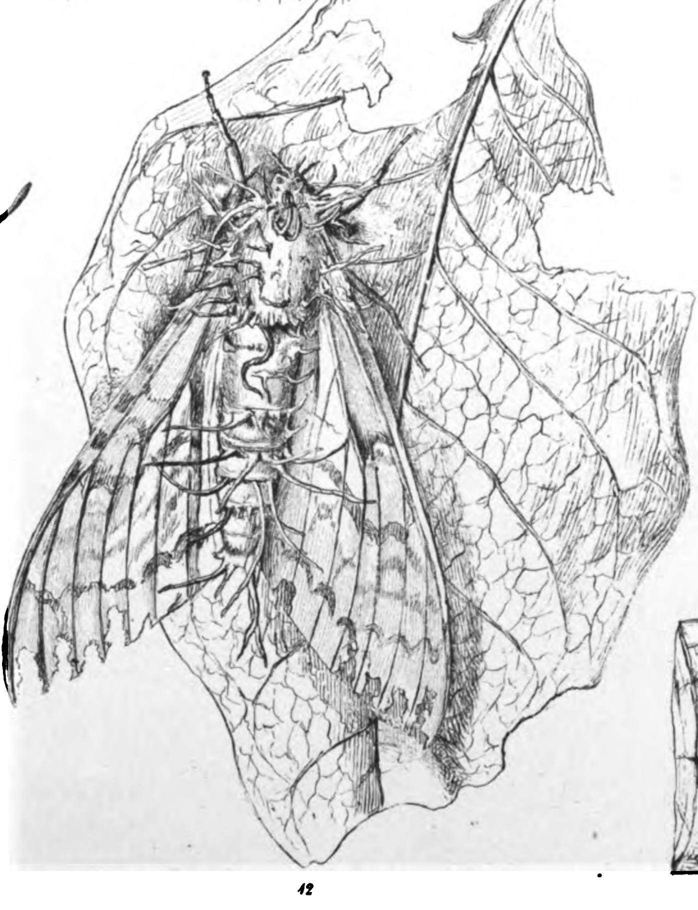
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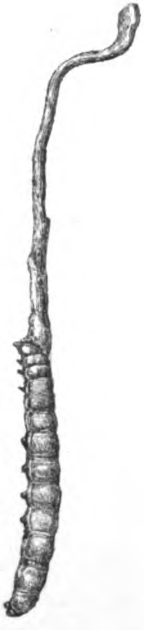
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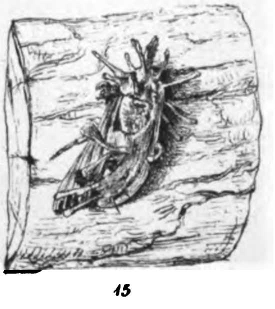
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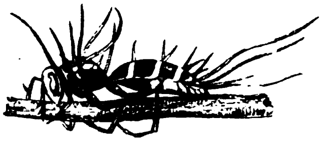

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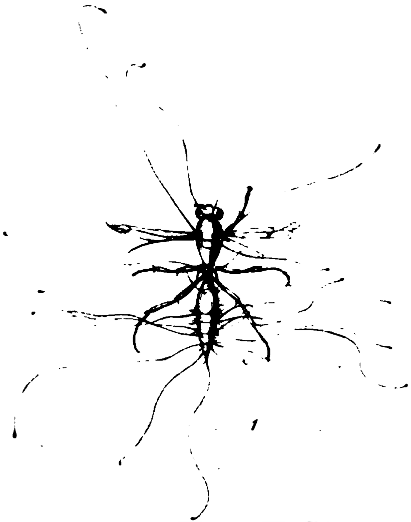

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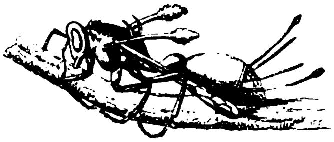

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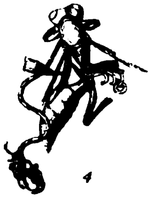

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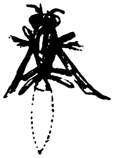

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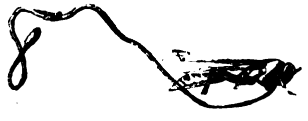

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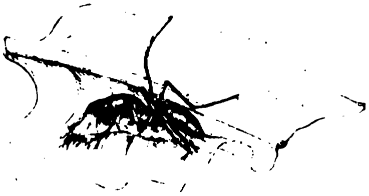

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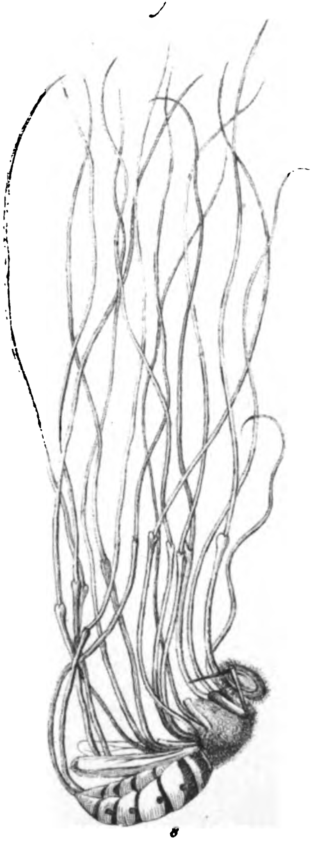

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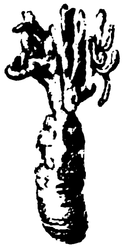

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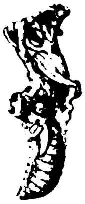

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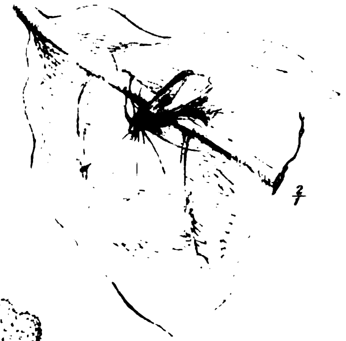

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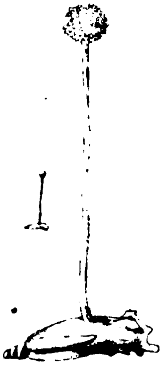

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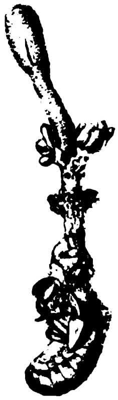

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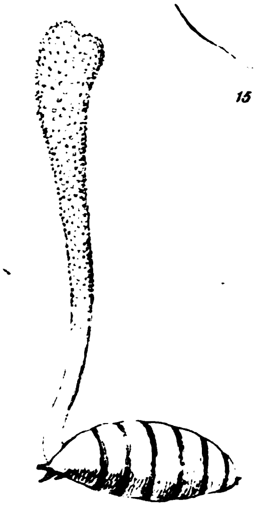

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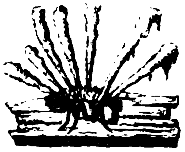

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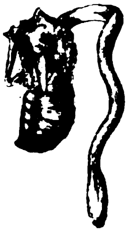

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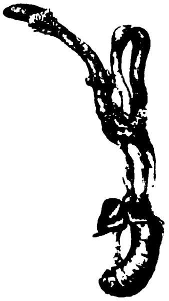

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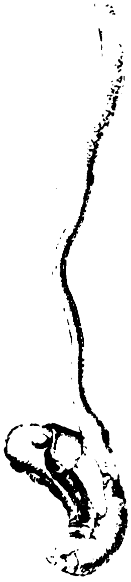

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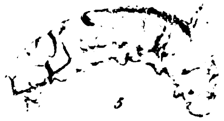
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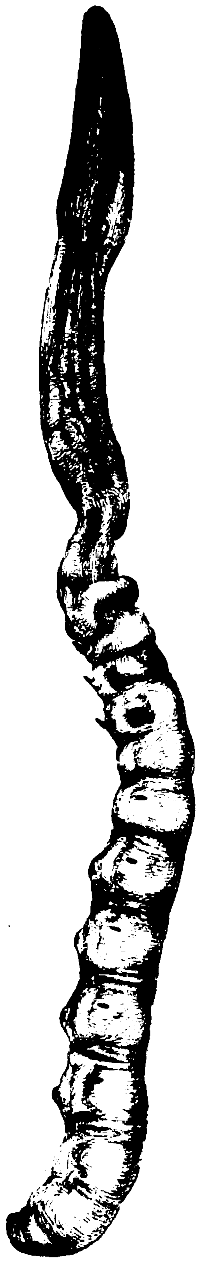
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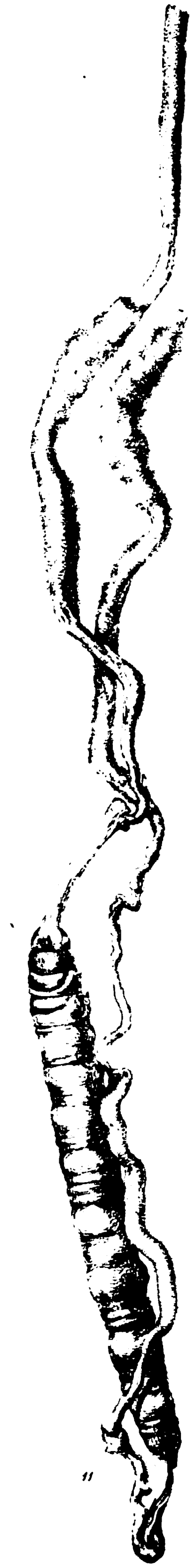
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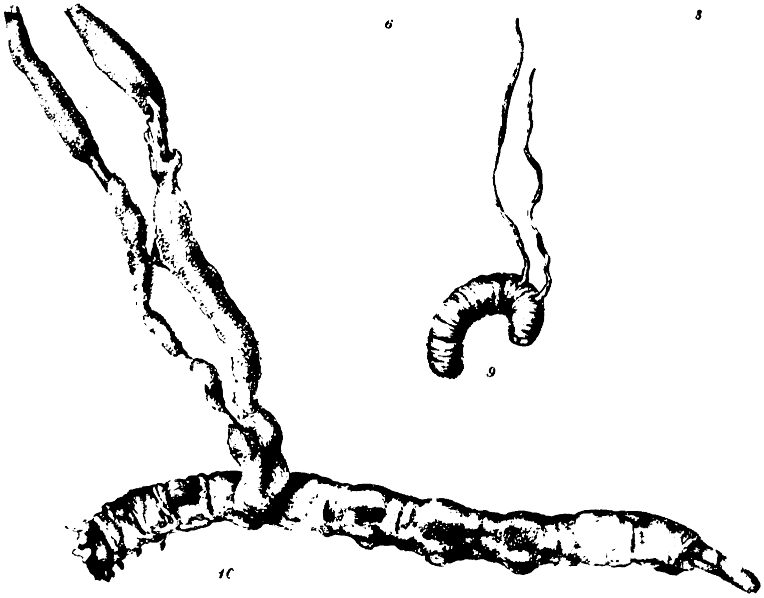
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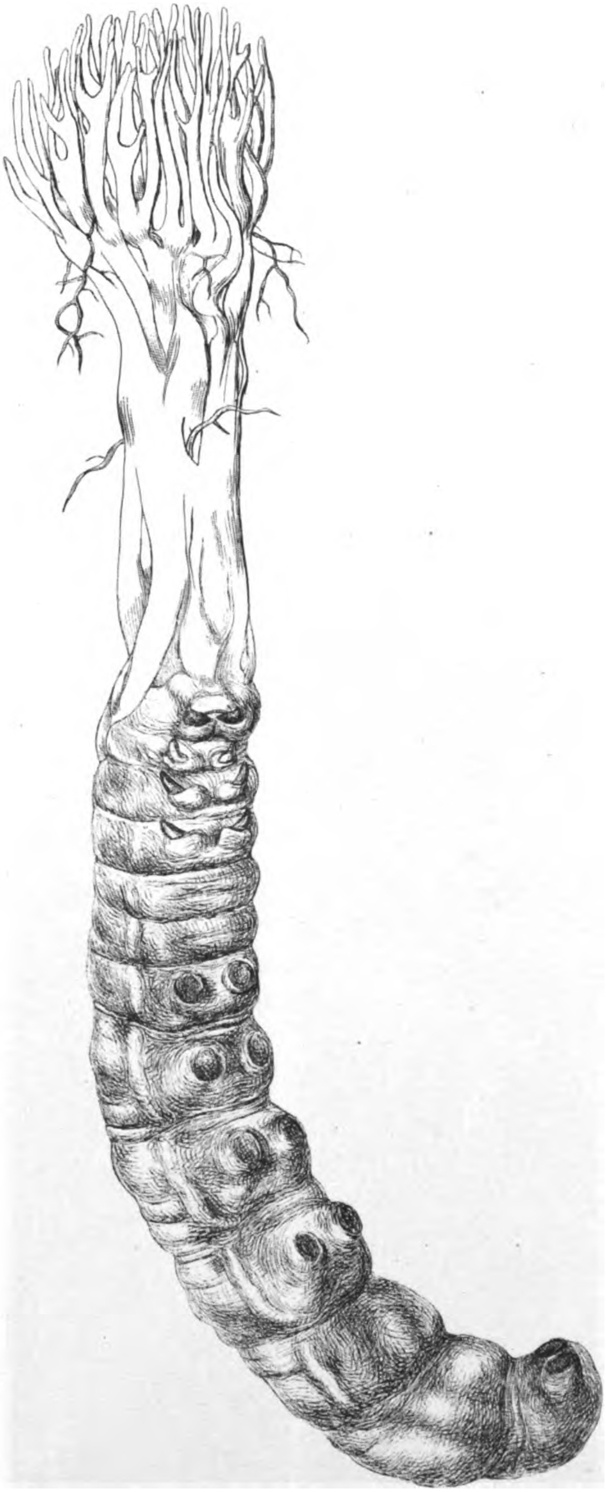
Pl. 6.



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